

Aviation Week & Space Technology

June 17, 1963

SPECIAL REPORT:

Advanced Rocket Motor Studies

Nihon YS-11 Transport

75 Cents

A McGraw-Hill Publication





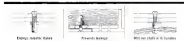
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... protection plus!

As equipment becomes smaller, lighter and more complex in the aerospace industry, the need to protect delicate wires and other components assumes greater importance. Economical Kaylock lightweight capped nuts eliminate the penetration of conductor insulation by the sharp edges and bare threads of protruding screws, thereby preventing possible damage to components. In addition, metallic fumes are entrapped which otherwise could interfere with circuitry. Capped nuts in recess holes of fluid compartments prevent leakage of contained fluid.

Kaylock capped nuts with the elliptical locking device meet and exceed the requirements of MIL-N-25307. Both the carbon steel and the corrosion-resistant A286 alloys are tested from 125,000 to 260,000 psi.

Write for additional data.



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New Goodyear Red Streak jet transport tire is so ruggedly built—it delivers as much as 15% more landings per tire—and airline records prove it.

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Next, reinforced tread ply design permits run of more rubber in the tread, protects tires from bottom tire tread chalking and peeling under severe high-speed, heavily loaded jet transport operating conditions.



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Plus Many Other Features...

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GOODYEAR

AVIATION PRODUCTS

So shake it!

New low-cost reflex klystrons designed to meet the severest environments of vibration and shock are now available from Sperry Electronic Tube Division.

An example is Sperry's SRU-4192. It offers 250 mW minimum output at any frequency you specify between 15.5 and 17.5 Gc. It's trim tunable across a 100 Mc range. It operates at an unusually low voltage. It's available within 30 days from receipt of your order, but with all these advantages it's priced far below comparable tubes.

Sperry has similar capabilities in other areas of the spectrum. If you need a ruggedized reflex klystron anywhere in X, U, K, or V band (8.2 to 40 Gc), Sperry has the answer.

To avail yourself of the outstanding performance of one of Sperry's rugged new reflex klystrons, place your order now. Contact your Cain & Co. representative or write Sperry, Gainesville, Florida. In Europe, contact Sperry Europe Continental, Paris.



AEROSPACE CALENDAR

June 25-27-1966 Annual Symposium on Computers and Data Processing, University of Denver's Denver Research Institute, Eldorado Lodge, Estes Park, Colo.

June 26-27-Symposium on Dynamic Load Problems-Honeywell and V-101, Shaker House Hotel, Buffalo, N.Y. Sponsored by Constellation Laboratories, Army Transportation Corp.

June 26-July 2-Symposium on Dynamic Loads, Florida Beach Hotel, Florida P. & J. Hotel 134-Conference and Symposium, American Engineering Society, Sheraton Hotel, New York, N.Y.

July 1-13-Annual National Conference on Aerospace Education, National Aerospace Education Association, Hotel Sheraton, New York, N.Y.

July 9-11-International Symposium on Space Transportation, Institute of Electrical and Electronic Engineers, Professional Group on Astronautics and Propulsion, Boulder Laboratories, Boulder, Colo.

July 15-17-Meteorological Symposium, American Meteorological Society, Ft. Collins, Colo.

July 17-19-66 Annual Powder Fall Days, Woodfield, Calif. to Atlantic City, N.J.

July 18-20-5th Annual International Conference, The Nevada-Nuclear Museum, Las Vegas, Nev.

July 21-23-Toronto Propulsion Conference (Continued on page 7)

AVIATION WEEK & Space Technology

June 17, 1962
Vol. 72, No. 24

SPERRY ELECTRONIC TUBE DIVISION, SPCRY SAND CORPORATION, GAINESVILLE, FLORIDA, is pleased to announce the availability of a new low-cost reflex klystron designed to meet the severest environments of vibration and shock. This new klystron, the SRU-4192, offers 250 mW minimum output at any frequency you specify between 15.5 and 17.5 Gc. It's trim tunable across a 100 Mc range. It operates at an unusually low voltage. It's available within 30 days from receipt of your order, but with all these advantages it's priced far below comparable tubes. Sperry has similar capabilities in other areas of the spectrum. If you need a ruggedized reflex klystron anywhere in X, U, K, or V band (8.2 to 40 Gc), Sperry has the answer. To avail yourself of the outstanding performance of one of Sperry's rugged new reflex klystrons, place your order now. Contact your Cain & Co. representative or write Sperry, Gainesville, Florida. In Europe, contact Sperry Europe Continental, Paris.

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AEROSPACE CALENDAR

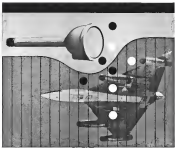
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 American Institute of Aeronautics and Astronautics, U. S. Naval Undersea Ordnance Laboratory, Newport, R. I.
 July 30-Aug. 6-11th Annual Fly-In Convention, Experimental Aircraft Ass., Redford, Ill.
 Aug. 4-9-International Conference and Exhibit on Aerospace Support Institute of Electrical and Electronics Engineers, American Society of Mechanical Engineers, Park Sheraton Hotel, Washington.
 Aug. 4-16-Sixth Annual Institute on Music and Space Technology, University of Connecticut, Storrs, Conn.
 Aug. 3-10-Eighth Annual Turbopump Symposium, Society of Propulsion Engineers, International Aerospace Association, Los Angeles, Calif.
 Aug. 12-14-Conference and Control Conference, American Institute of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, Mass.
 Aug. 14-15-16th Annual Gas Dynamics Symposium, Northwestern University, American Institute of Aeronautics and Astronautics, Evanston, Ill.
 Aug. 19-21-Aerodynamic Conference, American Institute of Aeronautics and Astronautics, Yale University, New Haven.
 Aug. 19-21-1965 Cryogenic Engineering Conference, Boulder, Colo. Sponsors: University of Colorado, NBS Cryogenic Engineering Laboratory.
 Aug. 19-21-1965 Western Electronic Show and Convention (WESCON), Cow Palace, San Francisco, Calif.
 Aug. 24-26-International Air Aerospace Flight Conference, American Institute of Aeronautics and Astronautics, Dorian Hilton Hotel, Columbia, Miss.
 Aug. 24-25-Conference on Physics of Entry into Planetary Atmosphere, American Institute of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, Mass.
 Sept. 3-11-International Symposium on High Temperature Technology, Anaheim, Calif. Sponsors: Stanford Research Institute.
 Sept. 4-11-Naval Meeting, Air Industries Ass. of Canada, Monaco, Barbours, Marine Hotel, Quebec.
 Sept. 4-12-13th Annual National Convention in Military Electronics, Institute of Electrical and Electronics Engineers, Sheraton Hotel, Washington, D. C.
 Sept. 9-11-17th Annual Instrumentation Automation Conference & Exhibit, Industrial Society of America, McCormick Place, Chicago, Ill.
 Sept. 10-12-National Symposium on Space Radiation, Space and Rocketry, Edwath AFB, Calif. Sponsors: American Astronautical Society, Air Force Flight Test Center.
 Sept. 14-15-17th Annual National Convention & Aerospace Assn., Air Force Assn., Sheraton Park Hotel and Sheraton Hotel, Washington, D. C.
 Sept. 16-18-International Aviation, Earth and Space Conference Symposium, Alhambra City, N. F. Sponsors: Federal Aviation Assn.
 Sept. 21-23-1965 Annual Operations and

(Continued on page 9)

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LITTON INDUSTRIES
ELECTRON TUBE DIVISION



PROBLEMATIC RECREATIONS 175



The sum and difference of two squares may be proved: $4 = 1^2 - 3^2$ and $4 + 1 = 5 = 3^2 - 1^2$ and $5 + 4 = 9 = 3^2 - 1^2$, etc. Can the sum and difference of two primes be squares? If so, for how many different primes is this possible?

—Continued

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ANSWER TO LAST WEEK'S PROBLEM: If we consider the letter in the first letter in one, two, three, four, five, six, seven, eight, nine,

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Beverly Hills, California

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the man
up front



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pilot's airplane

The pilot should be, and usually is, the deciding factor in the purchase of a corporate airplane. That's why so many pilots specify the Gulfstream with the handling characteristics, responsiveness, altitudinal ability and performance that appeal to the man who lies with it. ■ Because the Grumman Gulfstream embodies the pilot's own rigid requirements for safety and performance it is bound to be a sound business investment. ■ The pilot takes responsibility of selecting the best possible airplane for his company. That's why well over 100 Gulfstreams are flying for business corporations throughout the world today, and why important government agencies also fly the Gulfstream. ■ Next time you fly—in any corporate airplane—ask the man up front... he'll tell you why the Gulfstream is the most do-everything plane there is.



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AEROSPACE CALENDAR

(Continued from page 7)

- Midwestern Symposium, Milwaukee, N.Y.
Sept. 23-27—National Aeronautics and Space Engineering and Manufacturing Meeting and Display Society of Automotive Engineers, Anaheim Hotel, Los Angeles
Sept. 23-27—International Telemetry Conference, Sheraton Hotel, London, England
Sept. 23-27—Symposium on Electronic Engineering (London), American Institute of Aeronautics and Astronautics, Institute of Electrical and Electronics Engineers, International Society of Aeronautics
Sept. 25—Midwestern Annual Symposium on the Physics of Fluids in Electronics, Chicago 25—Symposium on Air Development (Creston), American Research Foundation
Sept. 26-Oct. 1-19th Congress, International Astronautical Federation, Paris
Sept. 26-Oct. 2—Mixed Interdisciplinary Exposition Meeting, American Institute of Aeronautics and Astronautics, Caltech Motor Hotel, Palo Alto, Calif.
Sept. 26-Oct. 2—Canadian Electronics Conference, Institute of Electrical and Electronics Engineers, Exhibition Park, Toronto, Canada
Oct. 1-3—Eight National Symposium on Space Electronics, Institute of Electrical and Electronics Engineers, Pasadena Hotel, Mount Royal, Pa.
Oct. 1-3—National Aerospace Nuclear Safety Topical Meeting, American Nuclear Society, Albuquerque, N.M., Albuquerque, Los Alamos Scientific Laboratory, NRC Aerospace Operations Office, AF Special Weapons Center, AF Directorate of Nuclear Safety, Sandia Corp., University of New Mexico
Oct. 2-4—National Assn. of Air Traffic Specialists, Sheraton-Orlando Hotel, Orlando, Fla. ORL
Oct. 7-9—North Atlantic Communications Symposium, Institute of Electrical and Electronics Engineers, Hotel Vero, Vero Beach, Fla.
Oct. 9-11—21st Annual Airpower Engineers' Electronics Conference, Aerospace Electronic Society, Los Angeles Auditorium, Los Angeles, Calif.
Oct. 10-11—2nd Annual Meeting and Conference, Airport Operations Council, Sheraton Hotel, New Orleans, La.
Oct. 14-15—Eighteenth Annual Symposium and Symposium, Air Traffic Control Assn., Sheraton Hotel, Dallas, Tex.
Oct. 15-17—Eighteenth Symposium on Ballistic Missile and Space Technology, Royal Tinsley Centre, San Diego, Calif. Sponsored by AF Space Station Div., AF Ballistic Missile Div., Aerospace Corp.
Oct. 15-16—Fourth North Atlantic Symposium, American Vacuum Society, Sheraton Hotel, Boston, Mass.
Oct. 17-18, Oct. 21-22—Anglo American Conference, American Institute of Aeronautics and Astronautics, Canadian Association, and Space Institute Royal Astronomical Society, Manchester, England
Oct. 17-18—Quinn Eimbek Hotel, Sheraton, Canada (Oct. 21-22)
Oct. 18-25—Fourth World and East Coast Conference on Aerospace and North American Electronics, Institute of Electrical and Electronics Engineers, Sheraton Hotel, Montreal, Md.

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Westcon's high performance standards are achieved through a superior packaging in its rugged and mechanical design, in strict machining and rigid quality control. In addition, Westcon offers unparalleled engineering experience. We designed and built the original U.S. indicators, and recently supplied most of the 35 indicating instruments aboard each Mercury capsule.

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Standard Display



Heading Distance-Reading



Basic Indicator

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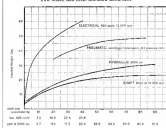
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Light pod,
10 lbs electrical



Missile, 225 watts, 6000 rpm electrical
(tailview)



Pod, 5 ship
shaft output



Pod, 2.5 lbs
electrical



Aircraft,
17 gpm 1800 psi
hydraulic



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Raytheon's offensive system for advanced tactical aircraft is the first to provide a unique combination of precise terrain avoidance and ground mapping with air intercept radar functions. The system includes a proven air-to-air missile with all-weather, all-altitude and all-aspect capability.

The ability to conceive and design the system is an outgrowth of Raytheon's progressive and continuing effort in airborne radar and missile technology.

Related experience includes design and production of the bomb/nav search and terrain avoidance radar for the B-52, the bomb/nav radar for the B-54, management of SPARROW III and HAWK weapon systems, plus detailed study and analysis of mission requirements for advanced attack aircraft.

For additional information, contact Missile Systems Division, Raytheon Company, Bedford, Mass.

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landing and take-off
on the DED 18AA (18,700 ft.)
Hendley mountain, with 2 crew
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whose qualities
have been confirmed
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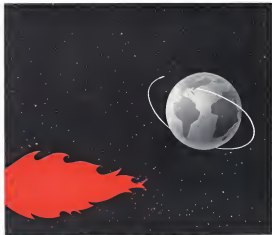
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bred and bred to prototype for reconnaissance and reform, this combat-recon vehicle runs on tires and tracks, achieves high speeds on and off roads. In proposing solutions to mobility problems like this, Clark Equipment Company applies more than 60 years' experience in developing and manufacturing power transmission, material handling and transportation equipment. Only Clark has this entry of demonstrated capability. Invite Clark to participate in an operations analysis, product or system development approach to your mobility problem. Write or call Manager, Client Development Division, Clark Equipment Company, Battle Creek, Michigan.

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Aviation Week & Space Technology

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France Leaps Into Space

Last week at Le Bourget we saw France leap into space with a program aimed at establishing itself as the third major force in the development of space technology, surpassed only by the United States and the Soviet Union. The French space program has been developing swiftly during the past 15 months. But the real impetus of part of this effort became evident to foreign observers only after a startling exhibit of French space technology at the 15th International Air and Space Show and a special presentation of the program's full details by top officials: Gaston Flerck, cabinet minister for aviation and space research, and Paul Ivan Colbois, director of the new French space research agency (CNES), headed this group.

Although the exhibition of modern aircraft at Le Bourget was, at times, superb, it was the evidence of the major French drive into space that demonstrated the drive—via the changing of its name to include space—along with aerodynamics. The French decision to lead Western Europe into space stems directly from President Charles De Gaulle's intuitive understanding that any nation hoping to survive in the modern world must develop its own capabilities, even the entire spectrum of key technologies (NVE June 10, p. 21). Evidence of this was seen by President De Gaulle against aerospace technology as a foundation of modern France came at Le Bourget when he stretched a scheduled four-hour visit to the show into 13 hr., including a 15-min. detailed inspection of the excellent NASA space exhibit. The visit was spent with numerous specific questions and answers in detail of U.S. space projects discussed at the show. This personal interest is reinforced by his decision to fund space research areas major for cases in the space technology spectrum, plus an operational program for six French satellites, at some time adding key funds to French aerospace programs to keep their expert aerospace teams rolling. These French moves in the aerospace field have been almost exactly the opposite of those taken recently by the government of Great Britain, whose a once superb technology in aerodynamics has been allowed to deteriorate and has little effort has been made to keep up with these technologies: nuclear, electronics and space technology. We predict that these government decisions on the new technologies will have a major effect on the relative roles of these countries in the leadership of Western Europe in the not-modistant future.

In its currently emerging character, the French national space program is organized basically after the U.S. pattern as agreed in relations with the military, industry and scientific community and elsewhere. Indeed, it has been greatly assisted by the U.S. through training of French engineers in satellite technology at NASA's Goddard Space Flight Center, and by providing the initial Aerobee and Scout boosters plus launch facilities at Wallops Island and the Pacific Missile Range during the interim before the French facilities become fully operational. France also is entering the international scope of its space program under bilateral agreements with India and Argentina involving boosters and scientific instrumentation. It appears certain that as the French space capability develops, its industry will become the source of hardware for many nations interested in these space program projects who prefer not to depend on the United States and Soviet aid left by the Soviet Union. Just as it did as well as developing its potential aircraft industry from the ashes of World War I, France is carefully planning its space program to avoid duplicating major efforts by the U.S. and Russia, such as manned space flight, and is concentrating on filling gaps left by those programs' venerable capabilities.

The prime reason for the serious advanced with postwar French aircraft as export markets was the unique character

of these products, which filled gaps left by U.S. and British aircraft and engines. The French space program, in new phases, appears to be aimed mainly at developing basic knowledge and operational capability in satellite technology. Not until this capability is achieved do the French plan to branch out in new directions and contribute to space services based on Paul J. E. Bussiere's work with atmospheric science satellites.

Meanwhile, the French industry, as it did a decade ago with supersonic aircraft technology, is working hard on developing a broad capability in the most modern technological related to space technology. Many foreign observers at the French space pavilion were surprised to see more than a dozen traditional systems from exhibiting space work ranging from glass-covered rocket engines with integral tanks, metal container systems, aluminum engines and small nuclear power sources to satellite structures, advanced space instrumentation, communications techniques and lasers.

Although France is developing its own space program and the required industrial support under a basic national policy, Paul Colbois made it clear that France will continue to be cooperative and cooperative with the joint European space efforts now being organized through ELDO and ESRO. However, he was equally emphatic that France does not intend to be closed to the past of these organizations in development of its own capabilities. Whatever possible, France intends to be in the forefront of any work in handling a complete program on their own within the framework of the ESRO objectives rather than just contributing segments to the overall program as is currently being done in the ELDO booster program. None of the top French space leaders appear to be underestimating the significance of the technical, financial and political problems involved in putting the Thorator into orbit. The French industry is having to get heavily for much of the technical knowledge it needs for its push into space, just as it faced the painful but necessary cost of taking part in production of supersonic aircraft at a time when more affluent nations guided at this cost.

Facing the price a decade ago gave France the European leadership in the supersonic age of aviation. The French again appear prepared to meet whatever cost may be necessary to lead Europe in the space age. Indicators of how the French are viewing this space effort as a long-term investment in the program organized under the direction of Gen. Robert Astouan, technical director of CNES, to advance French technical standards in construction and design of small satellites, while also providing facilities and responses for those things with maximum utility. France obviously is relying on its own generation to carry the real load in its space expansion.

At Le Bourget the large slide show of the U.S. space exhibit struck me as the best, most informative of France's first space showcase—the Chateaux de Versailles—costing an effort, as Paul Colbois noted, at one General mission. The United States' exhibit was truly impressive for the technical maturity and breadth of effort it expressed as proof of progress achieved since its initial space exhibit two years ago. The French exhibit reflects the youthful spirit of enthusiasm and determination that characterized the U.S. exhibit two years ago. In comparing the two it is clear to see how much can be accomplished when pioneering spirit and political support are strong. Hopefully, the French-American space showcase at Le Bourget will reinforce a worldwide attitude that the nations that are possible in expanding space's horizons when strong national capabilities are blended in sincere international technical cooperation.

—Robert Hite



The PERT evaluator (top left) reviews the dashed line critical path on the COED MARK II display. He uses the joystick to indicate with a small circle the activity or path to be revised. The new schedule estimate is inserted by push-button control.



A revised display (lower left) is generated instantaneously by the computer, and indicates the new critical path. Thus, program managers can see by instant display the effect of proposed changes. The results of this "test-drive" PERT analysis are then presented by the electronic computer printout showing new materials for the development team.

COED MARK II, a second generation Computer Operated Electronic Display, applies the combined brain power of man and machine to the solution of space age problems. Other applications of the MARK II, in addition to PERT analysis, include real-time displays of helicopter flight control, lunar vehicle steering, missile guidance simulations, satellite thermal response, and polynomial curve fitting. Engineers interested in projects applying advanced display techniques are invited to contact our Personnel Director, Bendix Systems Division, Ann Arbor, Michigan—an equal opportunity employer.

Bendix Systems Division



Anti-missile Race

Washington Roundup

U.S. is keeping abreast of Russia in the all-out effort to perfect an SCIM defense, but offensive penetration techniques are expected to stay ahead of countermeasures, in the view of Defense Dept. experts.

Dr. Harold Brown, Defense Dept. research chief, recently told the House Defense Appropriations Subcommittee that the advantage usually has over defense probably will be more apparent next year. But he stressed the reconnaissance "the major part of our missile defense is presently progressing will penetrate any defense which could be deployed in the near future."

Deputy appears to be better penetration suits than conceivable missiles, and the latter will be "pretty carefully" studied this year, Brown said. Air Force long has pressed for acceleration of Project Pluto, designed to develop a supersonic hypersonic missile (Sonic), and emphasized its penetrability ability.

Defense leaders are trying their hardest for a follow-on defense program to the anti-missile defense effort this year. They agree that no outside defense would be complete without others to protect the population against fallout from missiles presently exploded outside defended areas.

Russian Space Test

Russian point both here and abroad that Russia is about to launch a space spectrometer, but predictions of just what it will be range from a wilderness and ducking among by true space dogs to the advent of a serious competitor.

Not so much how spectacular the test, congressional leaders still insist they will cut the U.S. space agency's budget substantially. Senate space committee, which traditionally reserves cuts by its House counterpart, made it clear in confirmation hearings last week that some cuts were in order. President Eisenhower's next is far as to tell Republican congressmen that spending \$40 billion to get to the moon was just plain "nuts."

V/STOL Inquiry Brief

Chairman John Stennis of the Senate subcommittee investigating the X-22A contract aimed to Bell Co. p. 32 has an intention of prolonging the hearings to read the minutes being conducted by Sen. John L. McClellan on the TFX. Sen. Stennis plans to conclude the inquiry as soon as possible, even to not calling officials of the two companies unless they themselves request to testify.

Sen. McClellan purposely held off his TFX hearings last week to afford the X-22A inquiry maximum publicity. Both hearings are embarrassing to the Kennedy Administration, and have tormented Defense Secretary Robert S. McNamara's image as the man in control of a complex. This is the main reason the Administration decided to have Deputy Secretary Russell E. Gibson testify early in the X-22A hearings rather than wait the main witnesses until last, as in the TFX investigations.

One of the main issues in the parallel investigations is that the actual decision-makers, McNamara on the TFX and Gilpatric on the X-22A, were among the few who did not accept technical briefings on the real proposals. A key reason why Gilpatric rejected Douglas was because of his opinion of the firm's performance on Skybolt.

Test Ban Prospects

Key to solving at a U.S.-Soviet agreement banning atmospheric and underwater nuclear tests appears to be whether Chairman Nikita Khrushchev will back off from his past assertions on a complete ban.

Harold Wilson, British Labor Party leader, and after a three-hour meeting last week with Khrushchev that changes for a full test ban with the exception of nuclear by the U.S. "use not very helpful," but declared there was "more hope of an agreement" authorizing testing in the atmosphere, space and underwater. President Kennedy said the U.S. will not resume atmospheric tests "so long as other states do not do so."

U.S. and British officials will go to Moscow in July to try to negotiate a treaty with the Soviet Union. Soviet officials, under scrutiny of state film cameras, will head the U.S. delegation while Vladimir Vladimirov, minister of defense, will direct the British team. A resolution sponsored by 54 members favors banning atmospheric and underwater tests and declares that any cheating would be detected without months' experience.

Dr. Albert Fain will be named assistant secretary of the Air Force for research and development, a post left vacant when Dr. Buckwold McWhorter moved up to under-secretary of the Air Force. Fain, an aeronautical engineer and former USAF chief scientist, comes from Cornell Aeronautical Laboratory, where he was vice president.

The seven engineers from the Manned Spacecraft Center who developed the Mercury spacecraft concept—Willard S. Blinn, Jr., Robert G. Chilton, Martin Faget, Jerome R. Hunsacker, Caldwell C. Johnson, Jr., A. B. Kitchin, Andre J. Merle, Jr.—obtained a patent on the capsule June 18—the day the space agency announced the Mercury project had come to an end.

—Washington Staff



SPECIAL FRENCH SPACE PAVILLON at the Paris Air Show housed 37 exhibitions, both government and private. Models in foreground is the Diamant three-stage boost vehicle. Vents booster is at right and fuel-storing rockets are at left.



DIEHMA-DEVELOPED Cassini-type satellite is shown in model form.

French Government Plans

Paris-French government, with strong might into national prestige and prestige, industrial technological follow-up in rocket, is developing a broad national space program that should establish it as West Europe's leader in this field within next two years.

Beginning with FR-1, to be launched from the U.S. Pacific Missile Range in late 1964 or early 1965 with a Scout booster supplied by the National Aeronautics and Space Administration, the French plan to move quickly towards placing five scientific satellites into orbit, using nationally developed boosters.

Lanzels also located in metropolitan France also will be developed, and series satellites beyond the initial five will be designed and placed into orbit.

First all-French satellite and launch rocket, the FR-1, is scheduled to be flown in early 1965 by the SERES-developed Diamant three-stage booster. The launch site will be at Hammaguir, Algeria, in the Sahara near France's Colomb-Béchar nuclear test site.

Four other satellite projects already have been formally designated and approved by the French government.

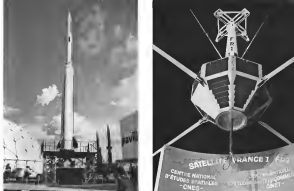
The planned space month, with dimensions unparalleled elsewhere in

West Europe, is being organized largely along established U.S. patterns. Booster development and launch techniques remain largely in the hands of the military, with the payload design responsibility assigned to a new and growing governmental agency named the Centre National d'Etudes Spatiales (CNES), whose counterpart roughly parallels that of NASA's Goddard Space Center, according to officials here.

Lois Goldford, CNES vice chairman of satellite and payload design responsibility, but will contract with private industry for most of actual development and production, and a number of traditional French aerospace firms already are becoming deeply involved in the space program.

Mercat Dussault, as an example, is working on several electronic projects, and Hispano Saiza is developing initial guidance systems. Nord Aviation is producing the FR-1, while Sud Alcatraz with SERES is working on booster work, and Potez is producing high-altitude research balloons.

As an indication of the importance France attaches to its space effort, CNES President Jean Chastolain reports directly to French Minister for Scientific Research Gaston Palewski who, in



DIAMANT BOOSTER, shown left, has a liquid-fueled first stage and solid-propellant second and third stages. The first two stages are SERES-developed and Sud has designed the third stage. French FR-1 satellite, right, will be launched by a Scout booster.

West Europe's Most Extensive Space Effort

turn, reports directly to President Charles de Gaulle.

CNES develops its efforts, representatives of a number of universities and research institutes, and these agencies will be called upon to make substantial contributions to the space program as a whole.

Organized directly over a year ago, CNES now has approximately 180 full-time men on hand at its Breigny headquarters near Paris and outposts, according to one official, growth to "several thousand" employees during the next few years.

The extent of government support and understanding of the need for a strong national space program was indicated here last week by Palewski.

Antenna Work and Space Telemetry speed coverage of the 25th Paris Air Show was done by a special editorial team meeting at Robert Holt, chief, Civil Aviation, European editor, Herby Calhoun, London Bureau chief, and Warren Whitson, European technical editor, edited by Robert Farrell, McCraw-Hill World News service correspondent. Photography was by Ron Appleby.

Commenting upon the extensive French space program at the Paris Air Show (AW June 10, p. 38), Palewski noted that France's efforts in the domain are destined to transform French industry as a whole, providing a fertile laboratory valuable even economically as well as military products that can keep France moving forward space with other Western nations in this area.

Palewski added that government plans to give full support to French space efforts, actual as well as those anticipated within framework of international European Space Research Organization (ESRO) and the European Launch Development Organization (ELDO).

CNES projects already approved include:

• **FR-1 satellite**, built by Nord, which will be launched by NASA Scout vehicle to orbit at an altitude of 200 km in late 1964 or early 1965. The payload—three experiments designed to measure the earth's magnetic and electromagnetic fields—is being designed by France's Centre National d'Etudes des Télécommunications (CNET), a department of the postal ministry, with CNES responsible for integration of the payload into the satellite shell.

In one experiment, FR-1 will attempt to measure very low frequencies emitted from three major subsurface communications systems. CNET scientists believe these frequencies can be heard in space and that if so, their measurements can provide new information on the atmosphere's structure.

The satellite and payload will be French-designed and built, except for



PROPOSED PHAEON SATELLITE option developed by SERES would be most precisely the solar and nuclear power source.



British Display Variable-Wing Model

Models displaying British Aircraft Corp's concepts of a variable wing wing, which the company is exploring under a Ministry of Aviation contract, were displayed at the Paris Air Show. Current cooperation of the model probably bears some resemblance to the still secret TSR-2 tactical reconnaissance fighter being developed for the Royal Air Force.



Sud Assault Helicopter Mockup Shown

Sud SA330 turbine-powered assault helicopter, now under development, is shown in mockup form at the Paris Air Show. Helicopter, with large doors on either side of the fuselage, is built around a suspended and will carry 22 passengers and a crew of two. It will be powered by two Turbomeca Bastan 7s.

external solar cell power units which will be powered from the U.S. space French industry will be begun in this area. Data received will be generated by two on-board telemetry units, including an advanced system developed by CNES.

In a preliminary to an actual orbital flight, an FR-1 payload will be launched to an altitude of between 125 and 137 mi from NASA's Wallops Island, Va., facility sometime this fall.

• **FR-2**, first satellite to be launched by the Diamant booster, essentially will be a flying laboratory for the French equipment involved. One feedback system attached to the Diamant's third stage will report to the booster's vibration and roll motions, while the satellite itself will carry experiments to measure radiation and effects of radiation damage to external solar cells. CNES officials now estimate that radiation, including the increased intensity resulting from U.S. high altitude nuclear explosions, will destroy effectiveness of FR-1 solar cells within five to six months, depending on communications with the satellite.

FR-2 also will carry several transmitters operating on various frequencies as part of an ionospheric beacon experiment. Total payload of the satellite will be 77 lb.

• **FR-3**, also a flying laboratory for the French system, including, eventually will be a scaled-up model of the FR-2. The payload weight will be increased to 95 lb.

• **FR-4**, the first French satellite in which attempts will be made to launch new scientific ground, will carry a payload designed to measure hydrogen distribution in the upper atmosphere. A measuring device was developed by Paul I. E. Bessant at CNES. A similar Diamant-designed experiment will be used aboard NASA's Pogo satellite.

FR-5 will be launched by the Diamant to study magnetic properties in space and also will be equipped as a laboratory for laser research.

• **FR-6** will be a sub-orbital satellite, but the final payload will not be determined until CNES officials have had an opportunity to study results obtained from earlier satellite vibration reports. CNES officials are studying several proposals for satellite orbital designs, but the final decision is still far out and not being made.

In a related research effort, France's Centre d'Enseignement et de Recherches de Médecine Aéronautique (CEIRMA) is studying biological aspects of space flight. Through a telemetry beacon of an actual satellite mission, although CNES says it has no interest in placing any cat in orbit. Launches begin with a cat in 1962, a cat scheduled to



CAT-CARRYING VEHICLE, above left, will be launched into a sub-orbital trajectory later this year as part of French space medical research program. Diamant satellite, right, built by SEREB, will be used in both of the Diamant launches.

be placed in future trajectory sometime this year using the Véronique booster. A monkey will be launched in 1964 with the Diamant model.

French scientists also plan to consider information transmitted from NASA's Nimbus weather satellite and will turn this data over to the French weather bureau.

In the satellite field, the French space position and other as shown in latest include a number of other proposed satellite designs from private industry which have not yet received formal government approval for final development.

While outside the Phasos for solar and nuclear space research developed by Société d'Etude de la Propulsion par Reaction (SEPR) in a study for CNES and the SNECMA-Germans 24-44, unclassified solar radiation solar satellite. The Phasos, if approved, would be placed in orbit with a 90-deg. inclination to the equator by the Diamant with an orbit period of 1.5 to 40 min. Payload would be 745 kg. and the apogee, 370 mi.

Several companies also are looking into the plasma jet research field.

So far in space is concerned, CNES President Costantini's explanation that the government at present has no interest in this area. Canadian budgetary requirements for such an advanced step, Costantini says, a move in this direction would be "short-term" for the French program. A project of this magnitude, Costantini says, would require off of currently anticipated French space funds and produce results less substantial than those already obtained by the U.S. and Soviet Union.

Present Diamant conjunction, designed primarily as a nuclear weapons carrier for the military, has the capability of placing a maximum 176-lb payload into orbit, while the second

generation design under study by SEREB scheduled to be completed by 1967-68, should be capable of handling sub-orbital larger payloads.

Current Diamant has a three-stage height of 33.9 ft and a launching weight of approximately 15 metric tons. SEREB-developed first stage designated Diamant, uses a liquid fuel nozzle while the upper second stage and the sub-designed third stage use solid propellants. The last third stage incorporates a small stage construction, and both the nozzle and the fuel are corporate monolithic technology.

Advanced Diamant would have two-stage launch as opposed to a single fixed unit on the present booster, and the last stage would have a thrust of 40 metric tons compared with 28 tons for the current one. The last stage also would use a solid propellant, and all three stages would be built to SEREB's design.

Under the Paris space agreement signed with Algeria, France will use the Sahara launch site until July, 1967 and Costantini says there is a possibility that the Algerian government might permit "possible" satellite launches after that time. CNES design at present is conducted under French space agencies and control.

To prepare for the 1967 mission, the Algerian launch facilities, the French army now is considering construction of a site along the South Atlantic coast of France, and Costantini says it would be available for use by CNES. The site, however, would permit launches only to the north-west, effectively destroying its usefulness as a satellite center, since vehicles should be fired in easterly direction in order to take advantage of the earth's rotation and the resultant gain in payload weight.

To provide for this in the event

branches from Algeria are no longer feasible—Costantini admits negotiation for any new stations probably would be lengthy—France also is considering the possibility of establishing a second site in the Provence area along the Mediterranean in the region of Marseilles near the town of La Cote.

France also is planning construction of its own tracking network, particularly through Africa, although it will rely primarily upon NASA's Minuteman for data collection from FR-1.

CNES engineers now are making surveys of Africa and other areas, including the Canaries, Madeira, to determine the best locations for four tracking sites which will form the base of the French space.

French monetary contribution is divided evenly between its national program on one hand and both the co-operative ELDO and ESRO programs on the other.

Unless ELDO waits the Diamant, Costantini indicated that France's only potential contribution would be the final development of an advanced version of the Véronique rocket as the second of three planned stages for the co-operative booster unit.

So far as ESRO is concerned, Costantini said, the French national program sought concentrate upon other areas of research while leaving solar satellites and lunar probes to be handled solely by the intergovernmental agency which has the task of developing common satellite systems.

Costantini predicted that the French parliament would complete approval of France's potential role with its organizations in the near future.

In its up-and-coming, CNES has designated a number of scientists to NASA's Goddard Space Center for at least six months study in their respective fields.



Bristol 510 STOL, military transport, with inflating flaps lowered, makes an STOL approach at the Paris Air Show. Landing was part of a display by French President Charles De Gaulle. Note extended landing gear.



Engins Moteur 500 engine low thrust aircraft, shown, designed to carry five persons for two 200-hp. Lycoming engines. Below, Yugoslav Galeb trainer is exhibited for the first time at the West. Note two seat gun mounts.



Prototype of the Franco-German Transall C-160 medium range helicopter transport is on static display at the Paris Air Show. Two variants, one built in France, the other in Germany, are now in flight test. Construction pictures are France's Nord Anjouan and Germany's West Flugzeugbau and Hamburg Flugzeugbau.

Paris Air Show Attracts Wide Aircraft Variety



Engins Moteur 500 prototype subsonic jet aircraft shown, is shown with tail section modified for respective second detection equipment. First and second prototypes of the aircraft have been modified to accept the MND 200. Below is the Dornier Do 28 private executive transport, powered by two Pratt & Whitney JT13 powerplants. Aliverte engines also are being considered (NW June 15, p. 40). The possibly licensed prototype participated in a number of flights during the show.



Navy Scores DOD Civilians' X-22A Role

By George C. Wilson

Washington—Navy made a breakthrough in the competition to fly the Defense Dept. jet with what Mr. George W. Anderson, outgoing chief of naval operations, said, the promise of receiving the aircraft "without adequate and through consideration in design," and "can only be determined by the competitive spirit of American industry."

Adm. Anderson expressed his confidence in the form of a recent statement that with the Strategic Program's ongoing Subcommittee that is probing the award of the X-22A V-STOL.

Lack of Technical Data Cited in Award

Washington—Defense leaders gave the Navy no technical reasons for awarding the aircraft's recommendation that Douglas Aircraft Co. be awarded the contract to develop the new V-STOL X-22A aircraft. Adm. Paul D. Stroup, who was chief of the Bureau of Naval Weapons during the competition, told the Senate Subcommittee investigating Subcommittees last week.

Adm. Stroup said the only reason Deputy Secretary of Defense Robert L. Gilpatric gave for selecting Bell Aerospace Co. was Douglas was Bell's greater experience in the field and its past performance. The Bell proposal was the highest one (see story). This is the first of Adm. Stroup's recommendations set in motion. Navy officials on June 7, 1962.

- "Each design a completed a high-risk contract."
- "Neither design a completed a prototype for future procurement."
- "Each design a completed a prototype for future procurement."

Based on the above reasons, a review of the chief of the Bureau of Naval Weapons that Douglas should be awarded as the winner of the award of the contract for the aircraft V-STOL aircraft if we proceed with the flight vehicle program is presently planned.

The Bureau of Naval Weapons has previously recommended that a program of component development be started on the basis of building one flight vehicle. The chief of the Bureau of Naval Weapons said today, however, that this approach might be considered. The best design, Douglas, often in search risk that a successful flight test vehicle may not be achieved. However, as an alternative program and one which probably offers absolutely the better chance of achieving a successful flight, component development. Although to initiate such a program at this time would appear to delay the flight research program and would involve a greater expenditure of R&D funds, it would certainly have a greater probability of obtaining more and more useful data in the long run.

"It is Douglas suggested that, instead of proceeding with the full scale program, the Bureau of Naval Weapons be directed to select the components only for development and that the flight research phase be completed using current equipment development. If this alternative suggestion is accepted, in view of the capacity of the Douglas design, it is strongly recommended that Douglas be selected as the contractor for component development."

The program development is part of the DOD directed Technology VSTOL Program. This is a national program, the national competition of which is the national interest. The Bureau of Naval Weapons is prepared to implement any decision made in this area whether by an internal component but program or a full-scale flight research program.

Adm. George W. Anderson, chief of naval operations, concurred in Adm. Stroup's recommendation and forwarded it to the Navy Secretary Fred R. Kothe. According to Adm. Stroup and other Navy officials, Bell received several other contracts, research in the last several on the basis of the Strategic Program. On June 16, 1962, Gilpatric wrote a letter to Secretary Kothe notifying him that Bell would get the contract.

research aircraft contract to Bell Aerospace Co. Navy had recommended Douglas Aircraft Co. on grounds its proposed design, technology, superior and changes to build (see box).

Other top Navy officials told the subcommittee they shared Adm. Anderson's view, and said they felt Douglas should have been awarded the contract, which ultimately may total \$150 million. The only justification they had received from civilian agencies for the reversal, they said, was a letter from Douglas Defense Secretary Robert L. Gilpatric, who cited Bell's greater experience in the V-STOL field and past performance on other contracts.

The subcommittee's V-STOL probe is being called "the little TFX investigation" because of the many parallels between the technology, superior and changes to build (see box).

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Central issue in both Senate inquiries, however, is whether civilian defense leaders are establishing new ground rules for procurement which threaten to reduce the influence of the military in the past where U.S. flight forces will secure, second-hand weapons. The X-22A investigation is one more example of Congress shifting its skepticism from civilian efforts to civilian defense leaders (AW June 3, p. 22).

Anderson's statement at the opening of the X-22A hearings June 12 was the strongest public criticism leveled by a military leader during this Congress against civilian removal of military involvement in aircraft procurement. "It is in my opinion a catastrophe," Adm. Anderson said, "that removal of military involvement recommendations made on the basis of long established and widely accepted procedures, involving as they do the professional advice of military and civilian experts charged with the technical evaluation of design proposals should not be continued except for the most compelling and urgent reasons. Second, such removal can only be detrimental to the competitive spirit of American industry."

"The navy says," he continued, "that the Navy has a strong interest in the program that is at a high level in the belief that such will accelerate technology program and associated to an extent that we cannot the most effective and efficient and therefore attainable. If other considerations are to be introduced into what hitherto has been a strictly competitive process, industry should know in advance the ground rules under which they are to seek new development and production contracts."

Adm. Anderson said the Navy in the past has conducted aircraft design competitions. "After growth rates will be established and accepted by industry" and had conducted such research in the past. He said the X-22A research case, as a complete answer" to Vice Adm. Paul D. Stroup, chief of the Bureau of Naval Weapons. Both Adm. Anderson

How Navy Evaluated X-22A Proposals

Washington—Navy estimated Douglas could build two prototype X-22A aircraft V-STOL, derived from research aircraft for \$20,100,000 and Bell could do the \$21,900,000, a difference of \$1,800,000.

According to the June, 1962, recommendations prepared by George A. Spangenberg, collection director for the Bureau of Naval Weapons, there were the other advantages the Navy saw in the Douglas proposal.

- Single electrical system. Douglas system called for a greater expenditure on a constant speed drive in turbine, but Bell proposed constant speed drive and more complex electrical and mechanical system.
- Transmission system. Douglas design used an oil bath design. "It is greatly preferred" because it is simpler, less more interchangeable units and is more easily repaired. Bell proposed multiple unit arrangement "which introduces design problems."

■ Fuel arrangement. "The first task at the top of the technology on Bell's design is internally more than Douglas' well-developed one."

- Vantage. Douglas' design allows them all around" for the pilot.
- Escape. Douglas provides system seats while the pilot in the Bell-designed vehicle would have to climb through a 35 in. square opening, step into a crew bay and then out and into a life line.
- Maneuver. Bell would have to live parallel, while Douglas would use a powered thrust to be level off.

■ Engineering. Douglas "has already studied the detailed design concept in greater detail and their proposal shows sound engineering solutions to many problems only discerned by Bell in general terms."

Spangenberg and Bell's design would perform better because it was a 340-hp, popper compared with the Douglas 625-hp, 400-hp. Also, Bell proposed a higher propeller rpm for hovering at a lower one for level flight, while Douglas propellers would have a constant 1,900 rpm.

Adm. Stroup and Gilpatric's letter directing Bell to be awarded the contract was so positive that they did not attempt to change his mind. Subcommittee Chairman John Stennis (D-Miss.) said the objective of the hearings is to determine "whether there were valid and compelling reasons for overturning the findings of the technical evaluation." Adm. Stroup and Kothe "are completely satisfied."

Gilpatric's role. Adm. Stroup said Gilpatric—as far as he knew—was never involved in the Navy's X-22A evaluation, nor did the deputy defense secretary ever consult with the Navy leaders before reviewing them. Adm. Stroup said Gilpatric's justification on grounds of Bell's V-STOL experience and past performance "do not balance or negate the technical reasons as presented earlier."

He said he agreed with Adm. Anderson's view. The aim of this whole process is to get the best possible weapon in the hands of the fighting forces, Adm. Stroup said. "We do not want to have any business questions and finally, the most recommended program."

Rear Adm. Robert S. Masterson, chief of the Bureau of Naval Weapons, said research development office of the bureau, also agreed with Adm. Anderson. Adm. Masterson said of such research continues, the ground rules should be changed to reflect the whole evaluation process becomes "confusing."

■ Military instability. Adm. Stroup said he knew of no evidence on military

official within the Navy who doubted the conclusion that the Douglas proposal was superior to Bell's. He said that those reducing the recommendation to award the contract to Douglas included William J. Anderson and Adm. C. V. Roberts, vice chief of naval operations.

■ Brown's recommendation. Brown said he agreed the Douglas proposal was the best, but said Gilpatric was on a meeting June 13, 1962, that "since both contractors could produce an acceptable aircraft, other factors should also be considered in making a decision," such as "value for money and performance." He said experience is especially important in an experimental proposal which makes engineering and technology. Brown said he made no overall recommendation on which contractor should be chosen, but thought Gilpatric's decision "was on balance the correct one."

■ Economic considerations. Warden said the fact that Bell was located in Southern N.Y. and that Douglas was located in Douglas, Cal., was not a factor. Douglas, Cal., was mentioned as a decision factor has level, but did not figure in the decision by Gilpatric. Warden indicated the Navy evaluation which included the Douglas design was imposed tentatively, but not by, nor, left Gilpatric's decision was "the right one" because of other factors. Warden said he assigned the hearing of the hearing and the aircraft was a taxpayer project.

Warden had told subcommittee in testimony that he does not wish to testify at the hearings, and Sen. Stennis has decided not to press the point.

Radio Disturbances

Disruption of radio communications on earth by spaceborne R.F. disturbances has become a serious problem. It is now estimated that some 50 to 60 high frequency radio waves in the high frequency band are now being emitted from the earth's surface and are being received by the earth's surface and are being received by the earth's surface.

Three radio radio signals are now being received by the earth's surface, according to the report of a Washington, D.C. report. The report states that the earth's surface is now being received by the earth's surface and are being received by the earth's surface.

These experiments were conducted by NASA's Goddard Space Flight Center.

Dr. Leslie G. Smith of the Goddard Space Flight Center, NASA's Goddard Space Flight Center, NASA's Goddard Space Flight Center, NASA's Goddard Space Flight Center.



First Air Force CH-3C Helicopter Rolled Out

First USAF/Sikorsky CH-3C, recently rolled out at the company's Stratford, Conn. factory, has a hydraulically operated cabin loading ramp for straight-in loading (AW Jan 10, p. 79). Helicopter is amphibious and has a 2,000-lb. capacity winch for external cargo loading. First flight is scheduled into this month. CH-3C will carry 15 passengers or 5,000-lb. of cargo.

Weightlessness Effects on Cooper Cited

By Warren C. Wetmore

Witness—Astronaut L. Gordon Cooper's testimony that he saw halos and other objects on the Tibetan Plateau during his Mercury Atlas 9 flight now suggests that visual perception and judgment may be adversely affected by weightlessness. Dr. W. R. Adey told participants in the Terrestrial Life in Space Session at the Committee on Space Research (COSPAR) meeting here.

Dr. Adey, a member of the Biota Research Institute of the University of California at Los Angeles, later amplified on that statement: "Whatever he saw, if his judgment was in good shape, as a pilot with thousands of hours of flying time he would know that he was absolutely impossible to see a 10-ft-dia object from an altitude of 700,000 ft."

Cooper's experience, Adey said, probably was not hallucination in the usual sense, but rather was due to a complex sense of well-being stemming from lack of gravity stresses upon his muscles and joints. In this state—which a scientist calls the "weightless" or "depth" state—occasionally experienced by divers—a impairment of critical faculties could arise.

If the high altitude of the Tibetan Plateau—well above a considerable proportion of the atmosphere—was thought to be a hallucination, Adey said, there were several defective mechanisms that he postulated, since the maximum resolution of the unaided human eye is of the order of 1 to 3 sec of arc.

Moreover, a dark object would tend to be outlined by the white background of the Himalayan snowfields, Adey said.

This occurrence goes as evidence of field need for carefully controlled, continuous investigation of human psychophysiological phenomena during deprivation of external sensory stimuli. Adey said, which has far more than been part of the U.S. space program.

even for 10 to 20 periods. No communication with personnel outside was allowed, and any external notes were effectively muted by sounds from ventilation blowers. Cabin portraits were shut down to prevent visual contact with the outside, and subjects were observed by closed-circuit television.

This reduced sensory environment was further impoverished by forcing the subjects to concentrate their attention beyond the point of external fatigue as performance of tasks involving spatial discrimination, problem solving, vigilance and perceptual judgment.

Relatives of the members of the subject unit were not advised. However, said, but certain others exhibited pronounced reactions.

For example, one subject felt as though his legs and feet had grown to enormous size and fluctuating capillary difficulty in manual operation of the task console. At one point he suggested that a 12-ft-deep hole had opened up as he attempted to sit. He felt his body to be elongated thin. On several occasions he felt as though his arms floated weightlessly in midair.

Another subject carried a blanket with him as a protection against movement of an electrical fire which had terminated an earlier test. During the 22nd hour of his confinement he began shouting, "It's real bad, but then to pull it out the TV set—it's real bad." He said he was turning all brown—the color turning into blue of his face, right in his face—better than at all in a hurry, it's getting bad as hell."

Although he is reluctant to dramatize the subject's feelings, his sensory experience was in the usual functioning TV monitor were brief, and he later

was moved from the chamber in a highly agitated state.

A third subject, who entered the chamber determined to report information, nevertheless thought he saw the TV monitor having weightlessly and had shown of face in the data of the task console. His attempts to react, however, probably were responsible for the learning to cope with the stress from by feeling more from them.

Subject to these problems, Flury concluded, may involve the advancement of sensory environments beyond such obvious techniques as communication with the earth, proposed in environment, data reduction, etc. A basic understanding of biological processes is needed.

Later COSPAR sessions focused on extra sensory life, especially on Mars. Study of its life forms will reflect future major evolutionary life on earth. NASA's Dr. Carol Signes told delegates. By comparing them to those of earth, it would be possible to determine the validity of the theory that in molecular and structural similarity to microorganisms by radiation pressure on earth.

However, Dr. Signes said, only the smallest could thus be transferred, since their mass must be the order of the wavelength of a photon. The theory that for our use, bacterial spores would necessarily be too small to possess shielding for survival in deep space.

A more optimistic outlook for the actual spread of life through the solar system was expressed by Prof. A. A. Ivanovskii of the Soviet Academy of Sciences.

"We have no experimental evidence of the stability of bacterial spores over a cosmic time scale to about 10¹⁰ years," he said. "Without these data at our disposal we cannot state that transmission of bacterial spores through an interstellar space is impossible."

Galileo, an instrument designed to detect and analyze life on Mars was approved by N. H. Horowitz of the City House Institute of Technology.

Key to this statement lies in the fact that almost all life on earth is life produced organic dioxide, which can be made radioactive and thus easily detectable by feeding them on a meter can containing carbon 14.

Two such instruments were being and the other for control purposes—would be incorporated into a capsule for landing on Mars. The radioactive nutrient would be contained in sealed capsules and the entire apparatus would be built standard in precise terrestrial construction.

After landing on Mars, spores will be present on nutrient from the microorganism. Each capsule will deploy 25-ft. lengths of silicon grease-impregnated wire. Galileo's wires will then and

the seed and absorbing Martian soil into a methane chamber. After the chamber is sealed, the spores will be broken and the culture medium released into the seeds.

Any organisms contained in the seed capsule that are able to metabolize the nutrient will produce radioactive carbon dioxide. This gas will be detected by a thin window Geiger tube and the data will be transmitted to earth.

Intensified contamination of other planets—particularly Mars—by space-borne terrestrial microbes is a major of extreme concern for microbiologists. Experiments conducted by R. S. Young, P. H. Oel, J. Bell and L. Allen at Ames Research Center have demonstrated that certain types of terrestrial microbes have not only withstood but actually thrive in a simulated Martian environment. These organisms survived a frozen three-day cooling between -75C and -130C during dry to night transition of the Martian equatorial season.

To provide contamination, control study a long series of methods for sterilizing spores. Several reports on the same presented at the conference, including the use of heat, radiation and chemical techniques.

One recent method, called gamma-sterilization, was used by Dr. F. C. Threlk of the Albert Einstein College of Medicine. This involves actual fabrication of spacecraft as a sterile environment enclosed by a mechanical barrier, an additive—individuals spores being used to measure gamma-sterilization.

In addition with made of a flexible film, which would permit use of rapid supports for the spacecraft. One such method, called the vinyl chloride chamber, given and even can be built into the walls for testing, repairs and assembly.

For more examples of examples, a well-known need for a pre-sterilized material and enter the outside area through a gamma-ray leak. Chemical agents, such as ethylene oxide or gamma rays, would be used to sterilize structures and the atmosphere.

This technique could possibly be used for repair and setting of parts over on the launch pad without need for re-sterilization, Flury said.

Other highlights of the COSPAR meeting include:

• **Study in the Martian atmosphere** has been detected by means of spectroscopic studies conducted in the Soviet Union. This phenomenon is concentrated around the equator of the poles, N. A. Kozlov said.

• **Two chapters have been discussed** on the earth's gravitational field in the course of geodesic studies of stations of light U.S. satellites, according to Prof. Fred W. Taylor, director of the Smithsonian Astrophysical Observatory. Locations of these phenomena were given as all the west coast of Mexico and north west of the top of India.

• **Highly sensitive** instruments to be dependent only on atmospheric density, applied with the knowledge of the magnetic moment moment, Prof. S. Fred Rogers of the U.S. Weather Bureau reported. Consequently, the effects of the study of several hundreds of years are possible for proton trapped close to the earth's surface.

• **One of the most important** investigations, according to the author, is the solar flux and trapped radiation, in relation to the study of the solar wind. According to Dr. Dwight H. Loehman of the Los Alamos Scientific Laboratory, there is now a 100-million-watt solar flux in the solar wind, producing, according to the author, which could incorporate an instrument for as long as 24 hr.

Bell Wins HX-1 Competition

Bell Helicopter Co., Ft. Worth, has won the USAF HX-1 competition for a mobile anti-aircraft helicopter with the company's modified OH-13 Apache anti-aircraft helicopter.

Bell was the winner of the competition for the anti-aircraft helicopter, which is being ordered in 1971 and 1972.

Although the number of orders was not disclosed, it is reported that 157 Apache helicopters will be produced with Bell 1965, 1966, 1967, and 1968 models, and 25 are being ordered in 1971 and 1972.

Competition consisted of two awards. An Apache initially specified that proposals were to be based strictly on either Federal Aviation Agency-specified or generic unclassified aircraft, with no modifications to perform the mission.

Initial proposals were filed by Bell Helicopter and Sikorsky last November. An Army decision that one of these robots met its requirements and requested further proposals which were submitted in February. Sikorsky did not enter the second phase of the competition.

Minimum Bell proposal will deliver from the standard helicopter by incorporating the 40-ft. main rotor blades of the conventional 1946 version (AW Apr. 29, p. 55) and will be powered by a General Electric T55-GE-6B derived from 1200 hp, to 1,300 hp. An Apache version of the OH-13 will be fitted with a cargo handling system and will carry up to 18 passengers and a pilot. Initial deliveries will start next year.

Half of Midas Spending Viewed as Waste

Washington—About half of the \$421 million spent through Fiscal 1961 on the Midas satellite program has been wasted, in the opinion of Dr. Harold Brown, director of defense research and engineering.

He told the House Appropriations Defense Subcommittee in testimony released June 10 that the money was wasted on "improvised system oriented hardware." The USAF Lockheed Midas project is an attempt to equip satellites with infrared sensors capable of detecting early warning of missile launches (AW Sept. 24, p. 54). USAF accepted \$190 million more for Fiscal 1964 to make Midas operational, but Defense Secretary Robert S. McNamara approved only \$75 million on Brown's recommendation.

Brown said the Midas program has been severely cut back because "the way the program was going, it would never produce a reliable, dependable system." What he meant by that was that within a year or two more operation of the program any result in obtaining the basic information which will then enable us to go to some other system. It would be a very different system from the one originally proposed.

Date Goals

The other half of the \$421 million, Brown said, has been spent on gaining data which is quite necessary for any system of this kind that we may develop in the future, and half is not going to be applicable." He said that Aerospace Corp. is now directing the program, but that Langley still runs the project contractor because of the knowledge it has acquired to date. Brown said the additional technological experience by Aerospace, "plus the new effort of the Air Force given us, and great care taken, but reasonable confidence of the future success of the program."

Subcommittee Chairman George H. Mahon (D-Tex.) questioned whether Lockheed learned on the project. "The company has failed to perfect that device . . . To go back to a company that has failed and to a government that has failed, and to people who have failed to solve that problem, seems to be somewhat questionable," he said.

When asked by subcommittee members why it had cost so much to find out the shortcomings of Midas Brown replied that each Midas-Air Force launch had cost between \$10 and \$15 million, for a total expenditure of about \$180 million. He and part of the reason for the program's failure was that "due to circumstances that were not very strongly considered from such an early

We didn't have enough to be able to go for a system in a complicated and demanding, as the requirements which were set.

Rep. Mahon and Brown differed over the importance of the extra 10 mm warning of a missile attack that would be provided by a perfected Midas. This was the exchange:

Rep. Mahon. It seems to me, Dr. Brown, that to some extent you have told this idea short. It seems to me when we understand (Midas) there was hardly anything to be gained from it. It was. In other words, we wanted the earliest possible warning of a ballistic missile attack. We were told that (Midas) would discover the launch, not when the weapon was in the air and headed toward us, but the very launching of it. Since we must depend upon minutes if not seconds, to react in some way, that is of the greatest importance. So, in some extent, if you can tell us, can you expect that there will be a case where coincidence was worth trying and that the answer which was put into the deployment aspect of this program, while actually sound, could not be any other of the navigation, have been known at the time that it would be useful.

Brown. I think that is a reasonable point of view, and I agree with it. Nevertheless, it does not appear to have been worth the cost of the extra 10 mm of warning. The time, the extra 10 mm, which secured very important and still seems important to some people, seems less important to me.

Weapons Advances

Washington—Defense Dept's research director does not envision a new breakthrough in weapons over the next 10 years, but he does expect that there will be an increase in explosive power comparable to the jump from TNT to the chemical and biological weapons.

Dr. Harold Brown, director of defense research and engineering, told the House Defense Appropriations Subcommittee that "the combination of both land and air weapons and biological weapons is a very big step change, and then there have been a lot of laboratory findings. In a real way the nuclear weapons is a relatively change to date, because Polaris is the most important kind of nuclear weapons. The future, I think, holds also some surprises and some advances, but the number of evolutionary changes we can foresee is not likely to be large."

and less important to Mr. McNamara, because it was going to be increasing the security of our country in a way which could not be the other way, we are less likely to be completely surprised and surprised out. In other words, the extra 10 mm was particularly useful for getting supplies off the ground. That was very important. It is not anticipated, but it is not quite so important now when we have a substantial missile force as well.

Rep. Mahon. You seem to downplay the importance of the 10 mm of warning because, you say, we are relying more upon missiles and less upon airplanes, and we have these missiles to some extent invulnerable to the missiles, but that is not the case. In fact, the 10 mm is not so important to the living, probably, of tens of millions of lives in connection with the safety and security of our people. I do not think you can ever say that the importance of this extra 10 mm of warning is not so important.

Brown. I think that is a matter of judgment here. A number of people, like the Air Force and on my own staff, feel that the extra 10 mm of warning is important to the civil defense and to guaranteeing the continued survival of the world. The studies that I have seen that look at detail at that people would look with the extra 10 mm of warning, and I agree with that. It is, the difference between you do with 10 mm warning, 20 mm, 15 mm, or 25 mm, is really not that great, I think. But I agree that this is a matter of judgment, and different people will have different judgments.

Time Element

When I look at what you can do to permit the new structure with the extra 10 mm, what you can do to get more people into the line and what you can do to take airplanes off so they are not caught on the ground, the last one seems to be much the most important.

The full information discussion of the Midas program was heavily reserved, even to leaving blank where the name Midas was used. Also, the Air Force director of changes that money was wasted was struck from the public record. It was clear despite the deletion of the project name from the record that the Midas was under consideration.

At one point Chairman Mahon and the experience with the project is mentioned in the line in brackets: "Midastide, turned all to gold." Rep. Mahon added "It seems to me we have been given a lot of gold."

Japanese to Re-study U.S. Sage Systems

Tokyo—Japan's Self-Defense Agency is to study a second survey team to the U.S. this week, to study coastal defense systems proposed by Lockheed Hughes and General Electric for Japan's early warning and defense control system (AW Apr. 15, p. 31).

Kenji Shiga, director of the Defense Agency, ordered the survey because of the agency's inability to decide which system to buy. Award of the contract had been expected in early last week, but final decision was not expected before early July. The program to modernize Japan's defense system has been under study since 1959.

Yoshio Matsuda, chief of the Air Staff, favors the Lockheed system, but cannot become a factor in the Hughes system, because of the Hughes system, which is a \$10 million cheaper. This figure that the SDA could pay close to \$10 million more than the Hughes system.

There is a three agreement system SDA, however, that development of the Hughes system, the only one not in use by the U.S., was not completed in time. Japanese are concerned that the Hughes system, which will be the subject of delivery.

GE seems to be out of the competition because its price, \$17 million, is higher than the \$10 million offered by Hughes. Hughes' price is \$10 million and Hughes' system is \$17 million and \$17 million respectively.

Storm Area Photos By Tires 7 Planned

Washington—Ten 7 reconnaissance satellite is scheduled for launch from the Atlantic Missile Range this week, in order to permit the satellite to obtain early data on the storm area. The launch and photos forming area during the forthcoming tropical storm season.

If the launch is successful, it will set a new record for successful T-10 launches in seven months, and 15 (strong) successful launches for the three-stage Douglas Thor Delta booster.

National Aeronautics and Space Administration and Tires 7 is to be launched into a 500 mi orbit at an inclination of 55 deg to the equator. The 207-lb satellite will carry two cameras with wide-angle-104 deg—11 deg lenses. The camera will cover a large area—about 75 mi in a radius—the satellite's mission is to make real experiments to measure the earth's best balance and on electron transport and density probe, the first such experiment to be carried on a Tires



Shrike Mounting on Skyhawk Shown

New Shrike air-to-air missile is shown suspended from a pylon under the wing of a Douglas A-1 Skyhawk. The weapon is designed to hunt a moving enemy against radar and other electronic warning systems. The Shrike is the first of a new generation of air-to-air missiles, which is being produced for Navy's Bureau of Weapons.

News Digest

Vehicle-Amesbury, last week, told Northeast Airlines it would acquire Northeast's fleet of 11 Viscount turboprop transports unless the carrier made immediate arrangements to pay the approximately \$2 million it owes the manufacturer. The Viscount aircraft were the subject of a lawsuit filed by the carrier during court proceedings before the Civil Aeronautics Board on removal of Northeast's vital Florida routes (AW June 3, p. 37), and threatened the airline's debt-laden future.

Ford Administration has been awarded a \$90,000 contract to study the requirements for a Minuteman missile to be used in a nuclear war. The contract was awarded by the National Aeronautics and Space Administration, as a part of a \$10 million study of the Minuteman missile system. The study contract was awarded by the National Aeronautics and Space Administration, as a part of a \$10 million study of the Minuteman missile system.

Space Technology Laboratories, Inc., Bedford, Mass., has been selected to build two Pioneer exploratory spacecraft for the National Aeronautics and Space Administration, as a part of a \$10 million study of the Pioneer spacecraft system. The study contract was awarded by the National Aeronautics and Space Administration, as a part of a \$10 million study of the Pioneer spacecraft system.

Indian government is considering dumping its program to manufacture the Avro 745 in favor of building the de Havilland Caravelle 1 turboprop aircraft transport. Caravelle's better high-altitude capability, the operational maintenance system is a major factor in its favor. Licensed manufacturer of Avro 745s was a former pilot of Indian Indian Defense Minister Krishna Menon.

General Aircraft Engineering Corp. has received \$88.9 million in additional funds from Navy's Air Weapons for A-6A bomber defense strike aircraft. Ford

ing concerns a letter contract to a definitive contract. Prime A-6A contracts total \$10 million.

Schlesinger S-61 jets, to be produced by Sikorsky, are to be used for the sale of the U.S. to a South Vietnamese. General overflight package in replacement for standard set of two A-1H jets. General Electric CT58 1181 shaft turbine engine. West Germany is newly considering in order to \$61 (AW June 18, p. 96). Chinese engine package will be shipped to the U.S. next year for installation in an S-61 aircraft.

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Total of 24 company manufacturers have been invited to USAF Electronic Systems Div. to submit proposals for installation of electronic data processing system to be used in base inventory control at 152 Air Force bases throughout the world.

U.S. Participation in Concorde Proposed

Time lag, American SST program cost may lead Kennedy to approve joining in Anglo-French effort.

By L. L. Doty

Washington—Surprise move to bring the U.S. into the Concorde super-sonic transport program is making strong headway.

The plan, developed in less than one week, was to reach top governmental levels late last week. It must have the approval of President Kennedy, French President De Gaulle and British Prime Minister Macdonald before it can be moved into an operational phase. The idea is known to have strong support of British and French government officials, and it is highly possible that the substantial costs of undertaking a super-sonic transport program as a single-national project (AW June 10, p. 40) will force U.S. Concorde participation.

If the plan is approved by the U.S.—and the likelihood is strong—quick implementation of the program can be expected. The British and French are determined to build the Concorde at 47 months, twice the super-sonic transport program, which will provide the January final of both countries from between second-rate industries.

Both countries are fearful of U.S. competition in the supersonic field, since a successful U.S. aircraft would deprive them of the lucrative U.S. market. One of the major reasons in the Pan American World Airways contract with Sud and British Aircraft Corp. for the purchase of six Concorde provides that the owner will be released from contractual obligations if the U.S. decides to build a supersonic transport.

The U.S. government is convinced it must build a supersonic transport aircraft if the nation's aircraft industry is to retain its prestige and remain on par with foreign manufacturers. But if new reports that the construction of a supersonic transport capable of speeds above Mach 3.2 prove economically unfeasible and the U.S. has a virtual monopoly from the President that the program is to be abandoned, it is doubtful that the program will continue to be built at a practical cost and operate profitably.

Thus, it is very possible that the U.S. if it decides to build an aircraft, may be forced to stay within the Mach 2.2 limitation, or in the same speed range as the Concorde. In such a case, the British and French will have a strong competitive edge over the U.S., since the development of the Concorde is already about two years ahead of any possible U.S. effort.

None of the three governments can be expected to view a supersonic program as a costly mistake as it is

limited market as practical. In addition, the British and French are deeply concerned that the U.S. may draw invaluable experience from the North American NB-57 reconnaissance-strike bomber program, which will provide U.S. aircraft engineers with a more sophisticated knowledge of supersonic operations and enable them to build a better transport.

The British and French are working in close cooperation on the Concorde project, and are not allowing the current factors that exist between the two countries to interfere with that cooperation. The approach to Pan American for the Concorde was made by Sud, with the full knowledge of BAC.

Lockheed SST Claim

Lockheed Aircraft Corp. officials said last week that his firm could develop a 2,000-hour supersonic transport and fly it within five years if a global new program.

The Mach 3 craft could be in service as early as 1975, costing 210,000 passenger-mile between New York and New York in 2.5 hr., using existing airports, according to Richard R. Higgs, Lockheed California Co.'s chief executive and research engineer. Titanium and steel construction would be used, with a layer of metal on the outside with the Mach 3 only wing to hold aircraft temperatures to 700°.

Lockheed has been engaged in super-sonic transport studies since 1958, and has evaluated more than 300 configurations, Higgs said. Government financing of a large part of the research and development phase of the supersonic transport is essential because of the program's capital costs.

The contract between Pan American and the two European manufacturers is a limited and escape clause is an immovable. Concorde's production at about \$750,000 minimum, \$92,000 maximum. Technical and performance data are not covered in detail.

Announcement of the contract triggered renewed congressional interest in the U.S. supersonic transport program, primarily due to the birth of the supersonic plan and re-emphasized the fact that the U.S. program had been allowed to lag. It was because of this last point that Federal Aviation Agency Administrator N. E. Hahn called on Pan American President Juan T. Trippe in December to choose his firm ordering the Concorde and, thus, to urge him to withhold the order announcement (AW June 10, p. 40).

Stronger forces behind the U.S. program have been the National Aeronautics Administration and the U.S. Air Force, who not only want to put the program into action but would prefer to see the U.S. undertake a Mach 2.2 program.

Concern is strong that no nation will build the aircraft. Pan American will shelve the contract with Sud and BAC if the Concorde meets all technical standards. North American Aviation has placed an order for a Concorde but BAC officials state they want more technical data—but both manufacturers cannot be obligated to participate in a program sponsored by their governments.

Lockheed's congressional exposure to the Pan American contract came centered on the need for a U.S. carrier to go ahead for its equipment requirements, and the possible effect the purchase of foreign aircraft will have upon the balance of payments. The other hand, the proposed \$1 billion needed to underwrite the program will probably cause still opposition by a budget-conscious Congress. The two private agencies would tend to ease this problem since the U.S., as a participant, will share in the costs and the aircraft will carry the stamp of U.S. engineering. Necessary appropriations, of course, will be released only when they are required should the U.S. move on its own.

Meanwhile, Boeing Co. and Lockheed Aircraft Corp. presented technical papers before an aerospace transport study by National Aeronautics and Space Administration last week. Both companies are engaged in analysis of low Reynolds for a supersonic transport,



NAVIGATION CHART for the Delta Mk. 55 flight track shows route from New York to Europe. Low frequency navigation lines and patterns on which flight path is recorded.

New York Airways Seeking IFR Approval

New York-Trip certification of a scheduled helicopter airline for intra-city flight (IFT) operations is the aim of a flight test program now under way by New York Airways and the Federal Aviation Agency (AW May 13, p. 35).

The carrier hopes that certification can be obtained by late summer, prior to the August/September winter months. New York Airways executed 39% of its schedules because of weather in the past winter. Spokesmen say weather cancellations could have been held to 15% under IFR operations.

IFT operations could have been a major headache in the three U.S. scheduled helicopter airlines until the New York Airways project. FAA spokesmen say they hope to obtain through the New York Airways project a new, thorough evaluation of what criteria are required for helicopter IFR operations. FAA has been in the process of certifying the Eastern Express flight standards division in directing the flight test program, which was previously run by New York Airways.

FAA has been in the process of certifying the Eastern Express flight standards division in directing the flight test program, which was previously run by New York Airways.

First Step

First step is a three-week certification of the Boeing Vertol 117 helicopter for IFR conditions. Next will be a 30-day evaluation of the Delta flight track, which New York Airways' program navigation and the test will conclude with certification of the carrier's 23 pilots for instrument flight.

John B. Gallagher, vice president of the airline, said that the carrier has been preparing for IFR certification since 1958. All of its pilots hold standard aircraft instrument ratings and New York Airways has been preparing since 1958. All of its pilots hold standard aircraft instrument ratings and New York Airways has been preparing since 1958. All of its pilots hold standard aircraft instrument ratings and New York Airways has been preparing since 1958.

with on the V-107. New York Airways has logged approximately 11,000 hr. on the Delta.

"Despite this being a relatively new system, we've never had a dual engine failure," Gallagher said. "It is a major modification now that will substantially improve reliability."

Last October, the airline was recording six engine failures every 30 hr. of operation with the Delta system. The problem was traced to a high rate of failure in the mechanical event valve on the engine's analog computer. Delta is now changing some of its analog computer components, eliminating the mechanical valve. Gallagher said this should bring reliability well above current levels, in which failures occur with the mechanical valve, have been reduced to one every 45 hr.

"Delta is particularly important to our type of operation because it operates on low frequency," Gallagher said.

Reliability of Reception

Low-frequency signals are, effective down to ground level in all cases, even in the mountainous regions of New York's Westchester County. A quiet town such as New York is a very high frequency station. A low-frequency signal (VFR) which transmits on low-frequency.

The Delta system takes its signals



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scribers here), we make up new maps for sky condition, ceiling, temperature, dew point, precipitation, and barometric pressure from 700 different Weather Bureau station reports.

Which means we not only know the weather your flight will fly through, but also the weather that will sur-

round it for thousands of miles.

It might also interest you to know that we have 49 men in meteorology—and every one of them has a degree in it or grew up in the field. 30 have been with us over 15 years.

And when they carry umbrellas, we all carry umbrellas.

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from a master station and three data transmission positioned in a triangle pattern, each approximately 70 mi. from the master. The master used by New York Airways is at Floydtown Heights, N. Y. Slaves are designated by miles with the aid station at Yonkers, N. Y., the people at Bardonia, N. Y., and the gates at Newton, N. J. The signals from a hyperbolic grid pattern, with about 2,000 ft. between the parallel grid lines.

Visual aid-out is backed up by Decca aids, which take bearings of the stations and provide the pilot with a cross-check on his needle trace.

New York Airways hopes that the Decca system will prove acceptable for IFR operations to instruments of 100-ft. ceiling and 4 mi. horizontal visibility. However, sources close to the program feel such systems are unlikely for local IFR certification, and that the most that can be hoped for are 200-ft. ceiling restrictions.

Second Evaluation

The current program is the second in which FAA has evaluated Decca for helicopter operations.

In the first, with the single installation on the V-44, FAA judged the system satisfactory (AW Feb. 22, 1960 p. 43).

New York Airways hopes that the dual setup on the V-107s, the improved operational reliability and the additional experience gained since the first evaluation will make the system more acceptable in the second study.

There is little chance that it will be approved as an enroute navigation aid. Although used extensively aboard local wing operations, the British European Airways, Iberia has not been equipped at a primary enroute aid by the International Civil Aviation Organization, as has VOR. Spokesmen within the FAA say that if New York Airways is certified to operate IFR, a VOR certification probably will also be required.

Repulsion of the problem posed by the use of VOR in dark areas at Wall Street and the proposed Pan Am Building window heliport (AW May 27, p. 36), FAA officials stress that it could be important for operations at the city's major airports, LaGuardia, Idlewild and Nassau.

Two tests not yet carried on the V-107s and which Colgate feels are essential for the altitude in IFR operations are an autopilot and a precise blade landing aid.

The last model LS-H, modified for helicopter use, appears to be working as well as a standard Colgate and Conquest and some of the wiring for installation of such a unit are already available on the V-107.

The airline has expressed interest in

U.S. Airline 1962 Turboprop Engine Maintenance Costs

Dollars Per Hour (100-240 Engine Hour)

	ENGINE MAINTENANCE EXPENSE					Total Engine Hours
	Total	labor	Overhaul Expense	Waste-oil Materials	Overhaul Reserve	
CANADIAN CL-44's						
Seaboard	34.10	4.43	5.14	0.49	15.79	69,300
Flying Tiger	27.82	1.83	23.87	0.28	4.23	174,126
Steele	34.42	1.41	16.54	0.28	17.19	31,143
ELECTRA						
Southwest	13.08	3.24	1.87	7.85		126,126
National	13.00	1.33	12.54	0.99	69.90	151,146
Boeing	17.17	2.40	11.29	1.90		279,444
Southwest	11.18	1.44	18.99	0.44	9.21	64,950
Western	21.70	0.93	21.37	1.26		126,144
American	34.71	1.23	20.68	0.43		264,444
CV-440						
Allegheny	39.06	2.47	36.81	1.38	19.70	4,300
WICKS F-27's						
U. S. AIRCRAFT						
United	3.00	1.29	2.08	1.64		479,426
Continental	4.45	1.84	0.57	1.63	6.96	141,714
Northwest	2.17	0.79	2.73		1.24	61,350
Piedmont	7.31	0.76	7.96	1.19	0.29	60,000
West Coast	5.27	0.68	1.13	2.19	0.44	36,990
Boeing	6.27	0.57	1.28	1.19	1.24	25,426
Great	4.97	0.42	1.93	7.42	1.33	17,214
Midwest	5.46	0.69	2.13	0.69	0.31	31,634
Delta	7.27	0.41	0.88	0.48	0.41	22,876
Pacific	6.27	1.19	4.84	1.00	0.54	38,340

* Rate is for year ending April 30, 1961

Prepared by Ray & Ray

a landing aid proposed by Atlantic Intracoastal Laboratories. Operating an instrument approach, the work is now in the research and development stage. It is designed to provide selective approach angles in the 6- to 20-degree range believed most appropriate for instrument approach. Light aids have been made with the aid at Langley Field, Va. and in France where approach angle aids were made down to 50 ft.

Another key item needed for efficient IFR operation is a flying surface for the V-107s. The 50th aircraft scheduled for delivery shortly to New York Airways, was used in solo testing tests at the Naval Canadian Air Force base at Oshkosh, Wis.

The tests showed that blade wing in the most critical configuration. These tests showed that the blades have self-shedding capability, down to 210 ft. Colgate and, for clearing below this level, the blades were equipped with a sensor-actuated pop-out shield, electrically heated for de-icing. To permit the de-icing, the V-107's electrical power output must be doubled. This requires larger generators.

"We'd like to have this installed on the helicopter by this winter, but there's no provision for it set in our economic forecast," Colgate said.

The current V-107s come equipped with auto-rotor for the windshield, pilot cabin and engine cowl, although a system has not been developed for de-icing the engine protecting the engine intake against ingestion.

The helicopter also has Vanda's automatic engine failure system, considered an essential item for IFR operations because it automatically provides correct altitudes.

Full Demonstration

New York Airways flight test program calls for full demonstration of IFR capabilities for the V-107 and its parts. The aircraft will be flown at speeds down to 50 kt., low (visual speed is 115 kt.). Turns will include a designated 150 ft. climb, climb capability 1,000 ft. above the field site with one engine inoperative. Flights must also show their ability to handle the aircraft with the stability augmentation system inoperative.

Colgate said all IFR tests in late last hour "under the hood," but that the program calls for flight under actual instrument conditions.

"We're desiring for full IFR certification, because that is the only way we can assure schedule reliability," Colgate said. "Anything less than complete instrument capability just won't do the job."

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Major U. S. Airports—Part 1

Walking Distance Main Airport Complaint

By Robert H. Cook

Washington—Recent \$3,000,000 series of eight new major hub airports by American, United and Eastern Airlines indicates that the terminals alone at least these two airports alone the needs of the passenger and how to meet them.

• A terminal with the octopus-like "finger" configuration, which can be extended nearly without limit as new gate positions are needed.

• An airport connection that most passengers are physically qualified for the New Frontier 10-in. Gate Club.

The volume of passenger gates about terminal walking distance, which was just even complaints and such growing out of the aircraft noise problem, will almost certainly face some major modifications to entry of the growing new "airport cities."

Distance Tests

To test the magnitude of this problem, an accurate perimeter was used during the survey, which covered San Francisco International, Oakland International, Los Angeles International, Chicago International, New York International, Dallas International, Atlanta-McCollum and Miami International Airports.

Dallas, designed from the ground up with the needs of the passenger first, provides a sharp, refreshing contrast in the confusion and complexity of most large airports. From ticket counter to waiting mobile lounge, walking distance is not more than 100 ft.

Atlanta, designed from the ground up with the needs of the passenger first, provides a sharp, refreshing contrast in the confusion and complexity of most large airports. From ticket counter to waiting mobile lounge, walking distance is not more than 100 ft.

100 ft., and Dallas will not be the only airport in the nation where a late passenger can check baggage and ticket, purchase insurance and make a departure at work 4 min.

This would certainly be impossible at any of the other airports surveyed, such as Chicago, Idlewild, Atlanta and Miami, where walking distances generally averaged 1 mi. To the largest in-line connecting passenger or international airport, that distance is often doubled as he charts a course through a bewildering maze of concourses and finger locations.

The question then poses for the future is "just how far will the traveler have to walk as traffic volume grows and new gate positions are needed?" Last year, Federal Aviation Agency figures show that domestic traffic alone reached 79 million passengers and a total of nearly 100 million are expected by 1975. While many of the larger cities such as New York will probably require additional airports, many others in the hub class may choose to add new fingers or extend further their present finger systems to accommodate new gate positions.

Ironically, the airline industry, which has built a reputation for pampering the passenger, has also noted and accepted the present finger design construction now causing the majority of passenger complaints.

As a case in point, the architect for Chicago Field suggests a radical terminal building with a mobile lounge at bus-type train to replace the distance the passenger must walk to the aircraft.

ger must walk to the aircraft. This idea, along with an alternate plan using a system of separate satellite buildings similar to that of Los Angeles, was suggested by the airlines on grounds that neither design offered the necessary aircraft parking or operational office space.

Dallas' use of the mobile lounge is being watched with more than ordinary interest by other airport managements, plagued with complaints over terminal walking distances. They envision the \$275,000-per-aircraft cost and contend the concept could not cope with the peak traffic volumes handled at the larger hubs. They emphasize that Dallas was built by the federal government with taxpayer money, as opposed to a majority of airports which are being funded under aviation bonds, payable solely from airport income.

Other Solutions

Most observers feel these airports have some ability, since Dallas' traffic volume was not such a volume high enough to give the lounge concept a real test in an early year.

However, other airport managements are working on other solutions to the walking distance problem.

San Francisco plans in 15 months to present using a 10-ft. narrow sidewalk to connect its present terminal building with a new south terminal now under construction. Cost of the construction, manufactured by Stephens-Adams, Inc., Co., Seattle, is estimated at nearly \$50,000. Denver is expected to adapt the moving sidewalk concept in the future. Dallas has been



First United Air Lines Boeing 727 Flies

First of 40 Boeing 727 transport aircraft ordered by United Air Lines takes off on its maiden flight at Boeing's Seattle, Wash., factory. Aircraft is powered by Pratt & Whitney JT8D-1 engines which develop 14,000 lb. thrust each on takeoff and cruise at 550 mph and gross weight is 152,000 lb. Deliveries are scheduled to begin the fall and United will put the aircraft into service in 1964.

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Contract to develop an advanced instrument approach and landing system suitable for use by supersonic transports, replacing existing ILS units in the 1970 period, is expected to be awarded by Federal Aviation Agency before July. The system is to use radar techniques and operate at X-band or K-band, and will include provision for independent ground-derived monitoring of aircraft approach. Four bidders include Hughes Aircraft Co. Laboratory, Bell Aerospace, Collins Corp. and Lohmeyer Inc. Electronics.

American Society of Travel Agents is planning a three-pronged attack aimed at the elimination of private charter lines on international routes and group fares. The society is demanding legal means of abolishing charter and group fares, activation of a special Washington, D. C., public relations council to handle the issue and a formal presentation to airline associations on the travel agent's importance to airline marketing development.

LGT Polish Airlines has made its first paving run on a new Warsaw-Varsavia-Cairo schedule, which will begin its regular once-a-week service June 17. Russian-built Il-18 turboprop transport, with 75 tourist and 12 first-class seats, plus a six-ton cargo capacity, will be used. Schedule is for Monday flights to Cairo with return service on Tuesday.

Special Air Transport Committee for National Defense has been organized by the Air Transport Assn. to improve effectiveness of the Civil Air Reserve Fleet, which consists of 142 first-line transport aircraft, about half of which are jets, on 90-yr. civil. Committee consists of 10 top-management officials of U. S. scheduled airlines.

State Dept. last week rejected its warning against U. S. commercial aircraft flying over Cuba. Withdrawal of the warning, issued last November following the missile crisis, was based "on the fact that foreign airlines have overflown Cuba without incident during the past several months," and any risk to the safety of U. S. operations are "insignificant."

Aeroflot has inaugurated regular morning service between Moscow and Damascus with B-14 turboprop transports. Scheduled line for the weekly flight is the 1,800-mi. run in 5 hr. The Moscow-Damascus service is Aeroflot's 10th international route.

Pan American World Airways' order of eight Boeing 797-300C turboprop cargo aircraft may lead to the industry's first mass breakthrough in high-volume cargo shipping. Last year the airline received 10,000 downsize and foreign aircraft containing the effect the new turboprops will have on delivery times and lower cargo rates. Pan American now has three 720Cs and will get the balance by next May. It is conducting marketing efforts on the shipment of specific commodity items. Sufficient volume could lower purchase rates by 50%, the airline estimates.

Labour Dept. achieved its first success in the voluntary abolition of labor agreements last week when Pan American signed agreements with the Flight Engineers International Assn. and the United Pilot Guild Workers of America. Three-year agreements assure that neither union will strike Pan American, and will accept voluntary abolition after attempts at mediation have failed. Agreement with FEAs does not cover crew complement issue, which has already been settled. Labour Dept. has already offered the same plan to other unions and is approaching other airlines. Latest project is Trans World Airlines, whose pilots have been pressing for a reduction in monthly flight times.

Boeing Air Lines has made its abrupt departure from standard airline advertising practices by engineering safety, and promoting industry aviation generally, rather than Boeing specifically. First billboard to reflect the second advertising concept reads "Don't Drive—It's SAFER to FLY, and Often Cheaper—Use Your Scheduled Airlines." Three other local airlines have indicated they will adopt similar advertising, because an industry-wide action has been initiated by Assn. of Local Transport Airlines.

SHORTLINES

Aeroflot has increased its total number of scheduled flights to about 1,200 daily—a record number for the Soviet airline magazine. Over 600 of the flights are made with jet or turboprop aircraft.

British Overseas Airways Corp. has reported an 85% increase in passenger traffic on the New York/Rome route in the two-month period ended May 15, compared with the same two months last year.

Federal Aviation Agency has approved lower landing fees for Pan American World Airways at Baltimore, Philadelphia, Detroit, Chicago and San Francisco. With a Sperry flight director providing pilot aid and control, the aircraft are being permitted to land on the base of a runway visual range of 2,600 ft.

Flying Tiger Line showed a 16% increase in air freight revenues in April, compared with the same period last year. For the first four months of 1967, freight revenues totaled \$5.5 million, a 15% increase over last year.

Eurel Air Lines of Spain has opened a new direct route between London and Valencia.

National Airlines has flown more than one billion revenue passenger miles on the southern transcontinental route since its inception in June, 1961 (AW May 6, p. 42). The carrier now operates on daily Douglas DC-8 round-trip flights on the coast-to-coast route.

Stoll Corp. last week received an \$8.5-million contract from Military Air Transport Service for operation of domestic air services within the U. S.

Trans World Airlines continued to show marked improvement in traffic during May (AW May 17, p. 46). During May, revenue passenger miles increased 19.1% over the previous month. International traffic rose 24.7% and domestic traffic climbed 11% during May.

Trans World Airlines will re-examine the first all-air transcontinental passenger service, inaugurated in December, 1950, as a 56-hr. flight from Los Angeles to Newark with a scheduled Ford Tri-Motor transport on June 25-27. The occasion is the 25th anniversary of the Civil Aeronautics Act of 1938, which was later amended as the Federal Aviation Act of 1958.



Moving 45 tons at 550 miles per hour is routine

for today's mighty jet transports. These transverse Boeing, Douglas, and Lockheed sky freighters are powered by Pratt & Whitney Aircraft's modern JT3D turbofan engines. Pratt & Whitney Aircraft provides design and manufacturing leadership in power for many applications, in and out of this world.

Pratt & Whitney Aircraft
U A



STEERED TO THE TASK!
The turbine-powered "Sea Sprite" hoists at 140 knots to the rescue. For this vital task, the new Navy helicopter must be reliable in every part. Critically important is the main transmission support—the frame beneath the rotor, connecting the power plant to the fuselage. The secret!

is largely lifted by this frame. The manufacturer, Kawasaki Aircraft, had to find a steel with a high strength-weight ratio that would keep the design compact and could stand up indefinitely under all field loading conditions. And it had to be reliable.

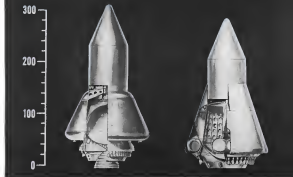
Timken aircraft quality steel tubes worked best. "They were

selected over other types," reports Kawan, "because their uniform adds reliability to the design." The result: severe stress were met, machining cost were cut down, rejects were practically eliminated.

Uniform high quality is a watershed in the Timken Company—has been for all the 85 years we've been in the steel

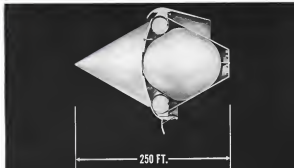
business. We have a long drag of victories over all types of steel problems. The ones who make Timken steel make the difference. What can we do for you? The Timken Roller Bearing Company, Steel and Tube Division, Canton, Ohio. Makers of Timken Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Circle 20 on Reader Service

Timken steel tubing and graphite tool steels are available from steel service centers close to you. Check the Timken steel representative nearest to you.



Stage Recovery Featured in Nova Class 3 Vehicles

General Dynamics/Astronautics and Martin Marietta Class 3 Nova vehicle designs recently selected by National Aeronautics and Space Administration (NASA June 30, p. 14), include GEVA fully recoverable. Heritage design (upper left) with booster engine which is jettisoned close to launch site (left) and orbit. GEVA vehicle on right, known as Nova, is a single-stage recoverable design. Martin vehicle (below), designated Keweenaw, is single-stage and uses the herbager tank to form a nozzle plug and the boostable ring for an oxygen tank. Keweenaw is enclosed in the air duct which has adjustable inlet ground circumference of the vehicle at the base of the nozzle facing. Firing losses payload and stress it as it is ejected during the air augmentation heat phase. Flaps (two shown extended at bottom) extend after payload separation to shut booster stage in early.





Problem: duplicate this environment...

and then maintain it out here

Before America's first manned space station goes into orbit, a whole new generation of problems will have to be met and solved.

To keep the crew in good health, for instance, we'll have to maintain their Earthlike environment for months or years. We'll have to devise a supply system to get food, air, and all the other necessities up to them regularly. We'll have to keep all their equipment in operating condition. We'll have to be able to work on the outside as well as the inside of the station. We'll have to develop vehicles and techniques for shuttling personnel to and from the station, as well as for in-space rescue.

Lockheed-California foresaw the scope of these problems five years ago, and brought together a team of scientists and engineers to specialize in man-in-space. The SpaceCraft Organization has developed a high degree of capability in all aspects of space station design. They have conducted extensive studies of techniques and vehicle designs for supply, maintenance, rescue and logistics in space. Today they stand ready to undertake the many vital tasks upcoming in this challenging new age of man-in-space.

LOCKHEED-CALIFORNIA COMPANY

A Division of Lockheed Aircraft Corporation, Burbank, California

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**Now...
for multiconductor cables
in toughest service conditions...
MIL-C-1377D
includes primary insulation of
TEFLON®**



Meeting the need for reduced size, weight and cost of ground-support multiconductor cables, the new "D" revision of MIL-C-1377D specifies cable that must perform with high reliability in every area of the world. Cables must withstand severe mechanical abuse, resist oil, ozone and weathering, and remain flexible over a temperature range from -65 to 160°F.

Included as primary insulation in this revision are Du Pont Teflon resins—both TFE and FEP. Their contributions to 1377D cables stem directly from their unique properties, such as high heat resistance (TFE withstands continuous use at 500°F., FEP at 400°F.). This property is still permitted a suitable reduction of cable diameter and weight for equivalent conductor-carrying capacities. Smaller cable diameters in combination with very low coefficients of friction between adjacent wires assure good cable flexibility. Teflon resins remove tough and flexible even at temperatures below -65°F. Terminations, too, are more reliable, because the insulations resist heat damage from soldering iron contact. Because Teflon resins are

completely inert to virtually all chemicals, they eliminate problems of fuel and solvent attack. And there is no danger of flame travel, as Teflon resins do not support combustion.

Thus, the outstanding insulating properties of Teflon resins contribute utmost reliability through demanding service conditions. Consider primary insulation of Teflon for your multiconductor cables. For further information, write: E. J. de Pont de Nemours & Co. (Inc.), Box 607, 2526, Nemours Bldg., Wilmington 98, Del. or Canada: Du Pont de Nemours Ltd., P.O. Box 660, Montreal, Quebec.



BETTER THINGS FOR BETTER THINGS. INVENTOR: CHEMISTS

Teflon is a Du Pont registered trademark for its family of fluorocarbon resins, fibers and films, including TFE (tetrafluoroethylene) resins and FEP (fluoropolymer) resins.

Hybrid Motor Operation

Operation of a hybrid motor is required to handle only one fluid (oxidant), thus it performs a simpler function than the system in a liquid-propellant engine. The hybrid motor superior attributes to the system in a liquid-propellant engine, which is easily overcome.

Solid phase of the hybrid propellant combination has the same general configuration as a solid-propellant motor, but it contains no oxidizer and therefore will not sustain combustion.

These factors affect weight and thrust-to-diameter capabilities because the burning rate is independent of the oxidizer rate of flow.

Practicalities later in hybrid motorization is that the liquid does not contact the surface of the solid phase once burning has begun. Combustion of hybrid propellants proceeds by thermal diffusion, decomposition and chemical reaction.

Combustion is started by the injection of liquid oxidizer to the solid surface of the solid fuel. If the oxidizer is liquefied, a cool, auto-catalytic action is started, generating heat for continued decomposition of the solid fuel.

After initial burning, the reaction proceeds exothermic and an active combustion zone is established. This zone is separated from the solid surface by at least 1/16 in.

Some of the heat from this combustion zone is devoted to the action of the solid propellant. The excess oxidation and decomposition is given off as solid or gaseous combustion material, which continues to support the combustion reaction.

Heat also flows from the opposite side of the combustion zone to convert the liquid oxidizer into a gas which diffuses into the combustion zone to maintain a reaction. The rate of this reaction is determined by the flow of oxidizer adjusted to the system.

explosion of rubber (hydrocarbon) and aluminum powder as the fuel gas. The nitrogen tetroxide is oxidant. Performance has been higher than with any established solid propellant.

Progression to a higher thrust engine is not indicated until an application allows a requirement. UTC is presently interested in boosting efficiency and obtaining better fuel utilization as a step toward reducing stated-the-art for hybrids to practical hardware. Studies are being directed toward more burning, preferred thrust and high combustion efficiency in a uniform and controllable manner.

Unique Condition

UTC's research with hybrids has shown that the burning reaction is insensitive to chamber pressure—a condition unique in chemical propulsion systems. Also, hybrids exhibit a very low sensitivity to environmental temperature.

Hybrids appear promising for space-stroke engines and for maneuverable vehicles which require long-term propellant availability and relatively unattended thrust. Considerable potential also is indicated for some of the more sophisticated ordnance applications.

Hybrids are not being used now as a practical configuration primarily because they are non-competitive with already developed propulsion techniques. No requirement has been defined to date which could not be met with one of these established techniques.

Nevertheless, feel that more exposure, background is necessary for straight forward hybrid design to present ad-

equity efficiency. Development efforts have cleared the possibilities of hybrid combustion, which should lead to the resolution of design variables for advancement of practical engines without extensive trial-and-error work.

All operational-oriented programs with hybrids are under the auspices of Advanced Research Projects Agency (ARPA), except for some Navy-sponsored research at Naval Ordnance Test Station and Aeronautics General Navy has sponsored in hybrid research since 1955.

ARPA projects include

- Fundamentals of hybrid combustion to provide design data for experimental and practical motor. This is a UTC research program, managed for ARPA by Navy's Bureau of Weapons.
- Development of seven hybrids (liquid fuel and solid oxidizer). This program is conducted by Throck and managed by DARPA for ARPA.
- Moderately high specific, hybrid propellant combinations compatible with field use requirements and incorporating on-off thrust command. The ARPA program is being conducted by Lockheed Propulsion Co. under Army Military Command management.
- Space-stroke, high-energy hybrid to deliver a specific impulse between 100 and 116 sec., with 1,000 psi chamber pressure, incorporating an optimum expansion ratio into standard reference conditions and various expansion ratio of about 10 to 1. The motor also would be capable of on-off operation and in-hole thrust command. This program is conducted by UTC and managed for ARPA by Air Force at Edwards AFB, Calif.

In a related area of engine work, UTC anticipates highly promising applications for ablatively cooled, liquid-propellant rocket engines. Development is in upper stages. The company believes these can meet requirements for low-and mid-range thrust values for durations up to 30 sec., in both steady-state and on-off modes.

Ablatively cooled chambers have already been selected for application to the landing engine (10,000-lb-thrust class) and return engine (3,000-lb-thrust class) of the Lunar Excursion Module (LEM), the transport (10,000-lb-thrust class) of Titan II, and the Apollo service module engine (21,000-lb-thrust class).

Ablatively cooled thrust chamber technology today has topped only a small portion of development potential. UTC anticipates any current technology will afford only low combustion chamber pressures (about 100 to 200 psi), using available available propellants in specific specific impulse of about 170 sec. under various conditions. Nozzle expansion ratio with these applications is about 40 to 1.

The ablatively cooled chamber is cooled by sublimation of some of its own mass into the hot gas stream. As the mass, the chamber is thickened compared with a regeneratively cooled unit, which has an indefinite operating life. However, the ablatively cooled chamber shows specific advantages over the regeneratively cooled type, including:

- Ablative low pressure-rated liquid system involves no induced pressure loss in the propellant supply system as a result of cooling applications.
- No purge gas flow, as in start is required for the regeneratively cooled.
- Ablative chamber is more rugged, would be less susceptible to physical damage from rocket motor penetration.
- Flowing effects in deep space would



erosion at the throat chamber there on 30, 400-psi pressure in the view of the chamber. Most of the chamber material and a method which would be used in the actual use. Current technology now chamber pressures from 100 to 200 psi.



Water Alcohol Check Valve



Oil Shutoff Solenoid



Thermal Relief Valve



Booster Regulator Valve



Brake Air Line Solenoid



Brake Fuel By Pass Valve



Fuel Injector Valve



Nozzle



Intermediate Air Line Valve



Pressure Regulator



Hot Shock Isolator



Fuel Throttling Valve

STUMP US

UAP has accepted challenges in valve design since 1925. Valves for aircraft and missiles. Valves to control fuels, oils, cryogenics, hot gases. Valves for high pressures or vacuums. Valves to operate in temperatures from -400° F. to 1000° F. Off-On or complicated metering valves. By-pass, relief and check valves. Regulators, shutoff, isolating and sequence valves. Special valves. One-of-a-kind valves. High production run valves. Valves, valves, valves, ad infinitum. Now, what's your valve problem? If UAP doesn't already have the answer after 33

years experience, we can find it. You'll get a precise, reliable, long-life valve. The only kind we make. Write or phone 224-3561 today. UAP means United Aircraft Products. A dynamic, independent company in Dayton, Ohio. A name to remember when it comes to valve development opportunities for modified engines.



be less pronounced for the ablative chamber.

While ablative chambers might apply to requirements up to 40,000 to 10,000 lb thrust in space systems, UTC says, the Indianapolis-based engine would show a distinct performance advantage over the pressure-fed design above the thrust level.

Use of the Indianapolis would involve operation with high chamber pressures. These would eliminate the possible use of an ablative throat because of the high rate of erosion as the ablative material under such pressures. Improved ablators would be required for this mode of use.

Damage Susceptibility

Main problem with the ablative chamber is that it is much more susceptible to damage from a poorly designed or defective injector than is a regeneratively cooled chamber. High injection control must be maintained in the fabrication of injectors for ablative chambers, since injector deficiencies might produce post injection patterns and "soft" or "cold" starts which might cause excessive erosion and burn-through. UTC designers note: Rapid chamber changes would affect these levels in a conventional test system and degrade engine performance.

System optimization with the ablative chamber using present-day materials limits operation to an upper level of about 300 psi chamber pressure for general applications. This stems from the fact that ablative rate is a function of the pressure.

General applications for the ablative chamber lie in the space segment, as distinguished from booster applications. However, ablative chambers are believed applicable to aerospace rockets which might use a chamber pressure as high as 1,000 psi for a very short duration time.

Mission and fuel ablative chambers generally falls into a single category—liquid alloy cloth bonded with epoxy resin. Various firms use different processes in cloth casting, lay-up orientation and method of curing.

Nozzle Construction

Typical construction of a nozzle chamber for operation with a chamber pressure under 200 psi and a duration of 10 min would embody a throat thickness of about 1 to 1½ in., with the grain-bound alloy cloth material decreasing in thickness toward the nozzle exit plane.

The ablative material would be surrounded by an insulator (best done of porous, low-density material) impregnated with a chemical about 1 to 2 in. thick. For structural integrity, the chamber would use a 1-in.-thick, epoxy-bonded, glass-fiber wrap in a helix



en-vi-ron'm'e'ics (an-n-eer'-ee'ks). New space age concept from AAF. Art of total-system environment control—developed, produced and installed through a single corporate source and engineering-management team. For example, the integral automatic system making each Missioner's needs and launch-control center environmentally self-supporting.

AAF Environments is not synonymous with air-conditioning; systems include ultra-high reliability features, shock-proof configurations, radio-interference suppression, filtering efficiency, and explosion-proof operation provisions that go beyond any conventional air-conditioning or air-handling equipment. In fact, no conventional concept limitations apply to AAF Environments.

Rebuke AAF Defense Group teams move quickly to the heart of any environmental-control problem. They develop all required designs, prototypes, tests, and test facilities. They draw on six AAF manufacturing divisions to fill all needs on schedule and without compromise. They provide and supervise installation in the field, with complete responsibility for hardware, delivery, checkout, operation, and maintenance of the system.

AAF Environments is founded on a unique range of products and experience—nearly four decades of pioneering in all phases of equipment, control, control and military. Ask for AAF Bulletin D-1644 and inquiries on your Weapons or Command system problem. Defense Products Group, American Air Filter Co., Inc., 2274 N. Price Road, St. Louis 35, Missouri.

	SYSTEM CAPABILITY
	• Heating
	• Cooling
	• Humidity Control
ENGINEERED ENVIRONMENT SYSTEMS	



Developed by the engineers who created Missioner's environmental control system. With contract for Wing I reconnaissance, AAF and its subcontractors are now completing installation on Wing II, Edwards AFB, D.



Vertical assault at 200 mph

Sikorsky's new CH-53A transport helicopter will be big, fast, and tough. It will provide the U.S. Marine Corps with its first all-weather, all-climate helicopter for vertical assault missions.

The powerful CH-53A will speed 30 troops or 8,000 pounds of cargo 115 miles at 170 mph—and return without refueling. On short missions it will transport 64 men or 16,000 pounds. It will carry a Pave program, 150 mm howitzer, or three-quarter ton truck. It is scheduled

for any terrain and offers a watertight hull for emergency function. Under light-load conditions, top speed will exceed 200 mph.

An advanced sea-landing cargo system will permit one man to load a ton a minute. Perched external cargo can be picked up in flight without a ground crew.

The CH-53A is based on the proven technology of Sikorsky's two-turbine S-66 Skyhawk. First flight is scheduled for 1964.

Sikorsky Aircraft DIVISION OF UNITED TECHNOLOGIES CORPORATION
UTAH

pattern. A three sheets of aluminum could be substituted.

It is feasible to use an ablative throat chamber incorporating radiation cooling as the expansion skirt. This can be achieved by use of a refractory metal flow approximately 1/4 to 1/2 inch into point out to the nozzle exit plane. Gas temperature and density in this location will have decreased to a value sufficiently low so that heat transfer rate is within the limits of available refractory metals.

Throat diameters for a 10,000-lb-class ablative throat chamber operating with a pressure of about 100 to 170 psi, weight be about 6 to 7 in. Chamber length could be approximately 1 to 2 ft and nozzle exit plane about 4 to 5 ft in diameter.

Plastic Feasibility

Feasibility of the all-plastic nozzle for solid-propellant rocket motors is the 120, 130 and 200-ton class sizes will depend upon an extensive research and evaluation program. Research may be directed in this direction because the availability of large graphite throats has been difficult to achieve, and few of these throats have been successful in large motor tests, UTC says.

Preliminary inspection of a 24-in.-dia throat with graphite liners revealed cracks which indicate low reliability of operation.

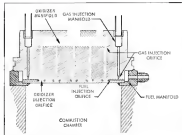
Another factor which poses the way for the use of the all-plastic nozzle in large motors is the transient effect of erosion in throat hot spots. The metal observer is to measure the percentage change in the nozzle throat area.

In small motors, a small amount of metal erosion (amount) of the throat will stimulate a significant change in throat area, reducing the chamber pressure and expansion ratio. In contrast, small throat changes in large motors create an insignificant effect.

Thus, in a small motor, erosion of the throat from 1-in.-dia to 7-in.-dia will result in a throat area increase of about 90%. However, a 2-in. change in throat diameter in a 20-in. throat, a size which might be used with the large solid motor now under development (AVC P-10, p. 300) would result in only a 10% increase in throat area.

UTC believes that a graphite throat nozzle for the large solid-propellant motor now under development could be designed for satisfactory operation at the above temperatures and densities which are expected for these motors. But the low risk that a graphite-throat or carbon-throat throat will be a simpler development. However, there is no indication that erosion resistance of the graphite throat will be equal to the metal backup.

For the reason, throat design for the



PROPELLANT INJECTOR DETAILS showing how gas injection is used to protect homogeneous gas-liquid nozzle in face section where for fueling. Throat area of 151 have been demonstrated with a 1000-lb.-throat engine.

largest solid motors always will involve a compromise between ease of development, fabrication and reliability versus erosion resistance.

The cloth could be obtained by submerging an exposed cloth in a chlorinating process. Exposure for longer periods of time at higher temperatures than required for the carbon cloth would produce a graphite cloth. After impregnation with plastic resin, the cloth would be laminated to provide the required configuration.

Normally, the use of graphite cloth or carbon cloth would be restricted to the area of high heat flux in the throat region. Erosion within the throat, the throat or other portions of located when in a matrix of plastic could be used.

Throat backup material might be a sub-plastic or carbon. In the 120-in. dia motor, thickness of the throat liner might be about 1 in. and backup thickness about 1 in. Outside surface of the nozzle profile would be strengthened by a glass fiber-reinforced resin.

Resistant Erosion

With this type of construction, a 120-in. firing of a large solid propellant motor might result in an erosion according to 5 in.

In solid propellant motor development, the use of metal additives to increase the erosion resistance of liquid fuels is gaining increased attention. Experience on this field of research is not as advanced as in solid fuels with metal constituents.

Metal additives for fuel are required to have high heat energy and low mass

losses. In the form of volatile products, their specific impulse is directly proportional to the square root of the thrust temperature divided by the molecular weight. In addition to increasing specific impulse of the propellant system, metal additives also increase the overall density of the system. This is an advantage in volumetrically efficient systems where high-energy must be contained in a small package, UTC indicates.

Densities of the metal as metal derivatives, such as a hydrocarbon, are greater than the densities of the liquid fuel. Therefore, some method must be found to suspend the metal or derivative in the liquid.

Additive Sizes

Particle size of the additive usually is in the 1- to 20-micron range. Small particle size is desirable to improve the propellant performance, but counteracting this is the problem of maintaining proper fluidity. Generally, a single particle in the 1- to 20-micron range is used. If particles smaller than one micron are used, fluidity may be improved because of the large volume of partial additive required to provide a desired weight of additive. Also, in small-size particles the presence of water content is controlled, affecting evaporation efficiency.

In the preparation process, a gelling agent must be added to the fuel and followed by the addition of the metal or the derivative to create a thixotropic gel.

Application of pressure, as in a pressure-fed system, will cause the



How many airplanes are in this picture?

We see at least eighteen.

We designed the Northrop F-5 to accommodate at least eighteen different combinations of air-to-air missiles, air-to-ground missiles, bombs, rockets, napalm, and extra fuel tanks.

Seven external stations on the F-5 will carry up to 6,500 pounds of payload and extra fuel, yet the F-5 weighs only 8,100 pounds itself, unfueled.

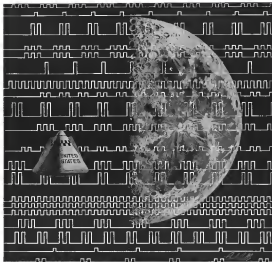
In clean configuration, the F-5 has a sea level rate of climb of 30,000 feet per minute, and can fly super-

sonic at altitudes up to 30,000 feet. In ferry configuration, maximum range is a healthy 1,650 nautical miles.

Yet with all this performance, the twin-jet F-5 is an extremely practical aircraft. It can land and take off from the sod fields and unimproved runways of for-

ward area bases. In operational squadrons, it will require considerably less man-hours of aircraft maintenance per flight hour than other supersonic fighters.

The F-5 can do many jobs, and do them well. **NORTHROP F-5**



AT RADIATION, IDEAS BECOME REALITY

Example: APOLLO's PCM Telemetry Systems

Radiation Incorporated offers the most advanced capability in PCM command, control and telemetry for aerospace. Because of Radiation's successful pioneering experience, the company was selected to design an entirely new telemetry system to accompany astronauts on the NASA Apollo Lunar Expedition.

The PCM system requirements: Astronauts in flight will check analysis, permitting no redundancy by the astronauts through use of replaceable modules; approximately weight 50 lbs.; requires approximately one cubic foot; channels are parallel and serial digital input, high level D-V and low level 0-50 mv analog inputs. Highly reliable qualified components are used throughout the system enabling highest MSBF to be achieved in mission performance.

Also, help 30 rack ground information handling system will serve as primary data reduction center. One will handle data from the capsule and the other later Schmitt's second stage booster.

Radiation engineers are experienced in complex systems development and design for maximum effectiveness within an entire project. The success of this project oriented approach has been demonstrated in a perennial projects such as Titan, Minuteman and Telstar.

If you'd like to take part in future contributions to aerospace communications you'll find a challenging and rewarding opportunity at Radiation. Send your resume, at write for information. Personnel Director, Dept. AW-843, Radiation-Melbourne, Melbourne, Fla. Radiation is an equal opportunity employer.



RADIATION
Melbourne
A Division of Radiation Inc. Incorporated

Ground/Space Information Handling System-Apollo's Command-IF System-Missioning

concrete fuel, which has dielectric properties, to flow.

Increases on the order of 40 sec of impulse are possible with the use of metal or metal-dominant additives presently available. These include, in the general order of their contribution to performance, aluminum, aluminum hydride, boron, and boron-hydride.

Lithium, a highly reactive metal, now have limited application as an additive for both liquid and solid fuels. Although lithium weighs less than boron and aluminum, this advantage does not offset the higher temperature characteristics of the latter two metals, UTC engineers say.

Handling Methods

Fuels containing metal additives are hazardous, unsymmetrical, dendritic, burning, and noncombustible. Oxidizers normally used include nitrogen tetroxide, nitric oxides of nitrogen, oxygen difluoride and hydrogen peroxide.

Largest benefit obtained by replacing metal or derivatives in a liquid propellant fuel, such as hydrazine, usually is derived with use of oxygen-containing oxidizers rather than hydrazine, such as fluorine, UTC engineers believe.

Problems associated with the use of metal additives in liquids are related to reaction design, since fuels with metal additives are nonNewtonian—viscosity is not directly proportional to the thrust rate. Combustion efficiency also may suffer, because metals do not exhibit as high a combustion efficiency as normal liquids.

Storage Life

Long term storability also may be affected. If the gel separates because of instability, the metal particles will tend to settle, leaving the liquid fuel as wet. This would result in clogging of the injector. Also, this separation could cause a condition of variable thrust, UTC says.

In comparison, metal additives in solid propellants cause no injurious degradation, and the problem of degraded combustion efficiency is not as serious as with liquid or corresponding additives.

Increases in specific impulse attributable with metal additives as solids generally are similar to those gained from liquids combined with additives.

Importance of improved thrusting techniques is emphasized by the requirement for variable thrust in the loading engine of the Lunar Excursion Module, as well as in the backup engine for the vehicle (AW June 1, p. 30).

Independent of thrusting, increased wet thrusting is the relative viscosity of the reacting propellant. This prob-

look to **TRANSCO** for Microwave

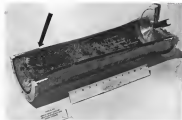
SWITCHES



- SPST ■ Excellent RF characteristics to 11 Gc ■ Wt. 12 oz. ■ 1,000,000 operations ■ Power, 300 watts C.W. at 2 Gc & less level
- Specifications, MIL-E-52726 and MIL-E-54332 ■ For airborne, airborne, and space applications.



Design and manufacture Airborne, Spacecraft and Ground Stations, Microwave Switches, Connectors and Spacers, Substrates and Interconnectors, Flexible Multichannel Connectors and Antenna Transmitters. We make everything from custom designed Transco Products, Inc., 4200 Bessie Ave., Yellow, Calif. Phone 800-101—area code 916



ABLATIVE THRUST CHAMBER prototype. Built at an level with nozzle exit cone. Ten had a quarter section cut from propellant injection point. In these passages to nozzle. Slightly cooled, blackened thrust area is indicated by arrow. Ablative material protects cooling effect by reflecting some of its own mass into the hot gas stream.

low, which results with a fixed-area injector, may be eliminated with a variable-area injector. However, performance may suffer as a result of poor atomization and mixing of the propellant. Also, the variable-area design involves mechanical complexities, as with a pulse arrangement.

Aerian concept of throttling uses a fixed-area injector and governs injection to maintain the injection scheme, while reducing the rate of propellant flow. This approach does not involve mechanical complexities and exhibits a fairly high combustion efficiency, according to UTC.

Propellant-fed system's performance goes below-paradoxically, could be used for the reaction process. A reaction gas probably could not be used because that would necessitate carrying a separate gas supply. Also the gas in thrust with the reaction gas would be itself because the mass of injected fluid is small in comparison with the propellant mass rate.

Additional injection of the gas would be limited to the fuel available, because introduction of the reaction gas into the oxidizer stream could create a combustion hazard which might destroy the injector.

Throttling rates of 35 to 1 have been demonstrated with reaction at the injector face in a 6,500-lb thrust engine, according to UTC. Given reaction, upstream of the injector, could easily give a 10 to 1 throttling rate.

Another approach to throttling is the use of dual manifolds for both oxidizer and fuel. The two sets are used over the full throttling range. At full thrust, all manifolds would be used, with good fuel flow during the entire on time.

manifold not to achieve 50% of full thrust. For throttling to about 10% of full thrust, the other set would be partially closed.

This technique would affect a specific impulse efficiency, equivalent to that of the reaction technique, and yield better performance than with the mechanical technique. It also would avoid the mechanical complexities of injector face-throttling arrangement, UTC says.

Phenomena of liquid-propellant combustion instability, amplified in engine size increase, is becoming clear enough to motivate destructive effects in future design.



Agena D Voltage Regulator Shown

Electronic hardware, direct current voltage regulator developed by IIT for use with Space 20A, an Agena D spacecraft consists of (1) filter box to eliminate source noise from regulation, (2) current regulator box containing sensing and servo system and (3) monitor plates. Photos are mounted externally from the regulator box.

A special wall, drawn formed by the Interagency Chemical Rocket Propulsion Group, is characterized consistently composed of personnel from ARPA, Air Force, Army, Navy, Johns Hopkins Applied Physics Laboratory's Chemical Propulsion Instrumentation Agency and National Aeronautics and Space Administration, has carried studies and the scientific discussion for data on combustion instability. This data will be used in a general analysis of the qualifications of this problem.

Two general forms of combustion instability in liquid-propellant engines are low-frequency oscillations, also known as chugging, which normally is not destructive, and high-frequency ("singing") oscillations, which can involve pressure fluctuations of the order of 3,000 psi. The latter have frequently involved destructive effects, according to UTC.

Low-frequency instability usually results from a coupling between the propellant feed system and pressure oscillations in the combustion chamber. The results can be eliminated through monitoring the pressure drop across the injector face. In monitoring pressure losses in the propellant feed system or by redesigning the injector.

Another technique for solving this instability is the introduction of gases upstream into the propellant just upstream of the injector face.

High-frequency instability, an extremely complex phenomenon, is not well understood. A general conclusion is that the larger the combustion chamber, the more susceptible to instability, and there is no filter which adequately defines the mechanism, UTC says.

"Give us a tracking station here

We want data on ICBM re-entry, here in the Indian Ocean where they impact... we need fully-instrumented missile tracking stations that are "floating islands"... able to operate hundreds of miles from land... to serve as the final link in the Atlantic Missile Range tracking network. And, we need them now."

In June, 1961, the U. S. Air Force Missile Test Center issued a contract for which there was no precedent. It called for the demobilizing of two wartime troopships—and their conversion into seagoing tracking stations. These ARIS (Advanced Range Instrumentation Ship) stations were to monitor the re-entry phase of missions on the Atlantic Missile Range. They would operate as far as 10,000 miles from Cape Canaveral... as near as three miles to "splash point."

please turn page

In 21 months, the answer



In record-setting time, 21 months after go-ahead, the ARIS industry team has delivered the U.S. Air Force Ship General H. H. Arnold—the most complete missile tracking facility ever put to sea. Soon it will be joined by a second ARIS ship.

Time Was Short. To accomplish the job as quickly as possible, the ARIS team employed new techniques. Procurement had been pre-planned. Six workdays after contract signing, the first ship was in dry dock. "Road-mapping" the project for PERT control, computers had already reduced hundreds of manhours of calculations to minutes. A special teletype link provided immediate inter-contractor communication. While the ship's bulkheads were being remodeled, bid-size equipment mock-ups were wired in advance to speed installation of actual instruments. Giant radar mount supports were precision-machined aboard ship. On-site shore tests of systems reduced trouble shooting after installation.

A Floating Island. The Arnold embodies the latest in integrated instrumentation, inertial navigation gear, data processing, and communications. Scientists aboard her will be able to gauge the accuracies of missile guidance techniques... compute air-terrain correlations during re-entry... determine whether warheads can be detected from decoys and "junks" sent through space with them... how to detect... how not to be detected. They can collect 25 to 50 million bits of data in a two-minute ICBM pass.

The ARIS radar system—six radars integrated as one—is the largest, most powerful ever put to sea. Associated instrumentation will permit terminal and mid-course trajectory measurements... astrophysical measurements... 24-hour laser probe monitoring... and much more.

The Arnold is the result of a deft combination of engineering skills... tested capabilities in system integration... and positive industry management. The ship stands forth as a worthy achievement of the Air Force and the

ARIS team. It will prove its worth to the nation as well in the years ahead.

This advertisement is sponsored by the following ARIS program firms:

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DYNATRONICS, INCORPORATED
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Systems Management, Navigation, Optics, Radar, Control Data Conversion

UNIVAC Division
Data Handling, UNIVAC 1200

Space Vehicle Log

(As of June 5, 1968)

1962 LAUNCHES	Designation/Name	Source	Launch Date	Recovery Date	Period (Days)	Apogee (mi)	Perigee (mi)	Group Name	Recovery Date
1962-1 Launch 1	Explorer 1	USAF	Jan. 4	Jan. 10	6	100	100	Jan. 4	
1962-2 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-3 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-4 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-5 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-6 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-7 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-8 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-9 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-10 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-11 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-12 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-13 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-14 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-15 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-16 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-17 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	
1962-18 Thor Agena D	Thor Agena D	USAF	Jan. 16	Jan. 16	0	300	300	Jan. 16	

1962-1963 LAUNCHES TOTAL TRANSMISSIONS	Designation/Name	Source	Launch Date	Recovery Date	Period (Days)	Apogee (mi)	Perigee (mi)	Group Name	Recovery Date
1962-1963 Launch 1	Explorer 1	USAF	Jan. 4, 1962	Jan. 10, 1962	6	100	100	Jan. 4	
1962-1963 Launch 2	Explorer 2	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 3	Explorer 3	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 4	Explorer 4	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 5	Explorer 5	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 6	Explorer 6	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 7	Explorer 7	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 8	Explorer 8	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 9	Explorer 9	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 10	Explorer 10	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 11	Explorer 11	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 12	Explorer 12	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 13	Explorer 13	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 14	Explorer 14	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 15	Explorer 15	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 16	Explorer 16	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 17	Explorer 17	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 18	Explorer 18	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 19	Explorer 19	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 20	Explorer 20	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	

1962-1963 LAUNCHES TOTAL TRANSMISSIONS	Designation/Name	Source	Launch Date	Recovery Date	Period (Days)	Apogee (mi)	Perigee (mi)	Group Name	Recovery Date
1962-1963 Launch 1	Explorer 1	USAF	Jan. 4, 1962	Jan. 10, 1962	6	100	100	Jan. 4	
1962-1963 Launch 2	Explorer 2	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 3	Explorer 3	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 4	Explorer 4	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 5	Explorer 5	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 6	Explorer 6	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 7	Explorer 7	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 8	Explorer 8	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 9	Explorer 9	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 10	Explorer 10	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 11	Explorer 11	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 12	Explorer 12	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 13	Explorer 13	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 14	Explorer 14	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 15	Explorer 15	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 16	Explorer 16	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 17	Explorer 17	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 18	Explorer 18	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 19	Explorer 19	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 20	Explorer 20	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	

1962-1963 LAUNCHES TOTAL TRANSMISSIONS	Designation/Name	Source	Launch Date	Recovery Date	Period (Days)	Apogee (mi)	Perigee (mi)	Group Name	Recovery Date
1962-1963 Launch 1	Explorer 1	USAF	Jan. 4, 1962	Jan. 10, 1962	6	100	100	Jan. 4	
1962-1963 Launch 2	Explorer 2	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 3	Explorer 3	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 4	Explorer 4	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 5	Explorer 5	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 6	Explorer 6	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 7	Explorer 7	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
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1962-1963 Launch 11	Explorer 11	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 12	Explorer 12	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 13	Explorer 13	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 14	Explorer 14	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 15	Explorer 15	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 16	Explorer 16	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 17	Explorer 17	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 18	Explorer 18	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 19	Explorer 19	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	
1962-1963 Launch 20	Explorer 20	USAF	Jan. 16, 1962	Jan. 16, 1962	0	300	300	Jan. 16	



The "Cherry Picker" machine hard-ly gets to plan.

The X-ray beam is generated in radiography source held on the X-15. Radiograph of heat weld made on "Cherry Picker" rig. Showing through honeycomb panel and solder through wire.

The weld can't come to the X-ray—
SO the X-ray goes to the weld



North American Aviation, Inc., Los Angeles Division, designed a "Cherry Picker" for on-line radiography of parts and welds on supersonic aircraft.

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KODAK Industrial X-ray
Film, Types AA and M
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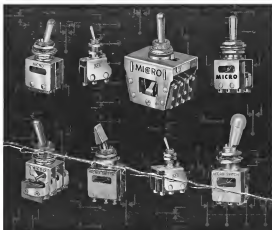
Radiographic inspection of fuselage welds is so important, North American Aviation designed a mobile x-ray track. It was quickly dubbed the "Cherry Picker." It can be maneuvered into confined areas, reach up twenty-seven feet and inspect twelve feet. An X-15 fuselage or airplane's honeycomb panel can be examined without being removed from the working job.

- No darkness needed—film is sealed in lightproof envelope.
- Just place Ready Pack in position and expose.
- Take processed film out, dry, light, and measure.
- In the darkness, remove film from envelope and process.

Radiography is increasingly important in proving the soundness of welds, of castings, of assembled assemblies. Components large and small rely on radiography for assurance that only high quality work is delivered—highly important in maintaining the kind of reputation that attracts and holds business. If you work for you too. To find out how, contact an X-ray dealer or write us to have a Kodak Technical X-ray Sales Representative call.

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HUNDREDS OF TOGGLE SWITCH ASSEMBLIES FOR GREATER DESIGN FLEXIBILITY

Tailored designs to solve a wide variety of control problems—cost-increases to simplify circuit design, increase reliability and save space—are available in the broad MICRO SWITCH Division of "H" Toggle Switch Assemblies. These dependable units are used extensively in electronic, aircraft, radio and marine applications.

They provide ways to solve up to a dozen miniature precision snap action switches—each one designed toggle assembly line offers complete design versatility with a broad range of circuit configurations; 2 and 3 position toggles, momentary and momentary/latch positions, pull-to-unlock, break, locked/latch.

and special features such as "electric memory" and "dry circuit" capabilities. Write for catalog 73, or call our Branch Office (see Yellow Pages).



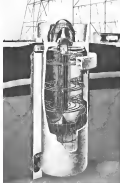
MICRO SWITCH

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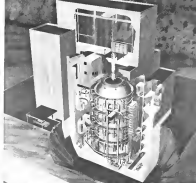
A DIVISION OF HONEYWELL

IN CANADA: HONEYWELL CONTROLS LIMITED, TORONTO 17, ONTARIO

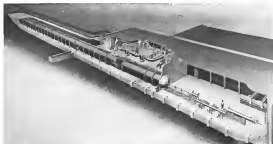
HONEYWELL INTERNATIONAL (HONEYWELL SERVICE OFFICE) IN ALL PRINCIPAL CITIES OF THE WORLD. HONEYWELL DIVISIONS: AUTOMATIC CONTROL, ELECTRONIC, INSTRUMENT, THERMAL, VACUUM.



FACILITIES FOR AEROSPACE RESEARCH at USMC Naval Engineering Development Center, Yorktown, Va., will be expanded in a \$31.4-million program now under way. Among the facilities to be built are Rocket Test Cell 1-4 (above left) which will accommodate vertically mounted engines of up to 500,000 lb. thrust at simulated altitudes of up to 100,000 ft. With modifications it could accommodate 1.5 million lb. thrust engines. Also, right is Environmental Chamber No. 3 which will be able to simulate altitudes of up to 300,000 ft. Chamber, which will be 65 ft. high and 35 ft. in dia., will accommodate full-scale aircraft.



Arnold Research Center Expansion Under Way



HYPERSOLOCITY BALLISTIC RANGE, now undergoing checkout, is 1,000-ft.-long, 10-ft.-dia. tube in which altitudes of up to 50 mi. can be simulated. Millions of reentry temperatures and pressures and their influence on spacecraft design as well as plasma sheath and nose cone interaction problems will be studied. Launchers (bottom, at right), will fire missiles at 20,000 fps velocity and later at 35,000 fps.

AFOSR Awards

An AFOSR Office of Scientific Research recently awarded grants and contracts totaling approximately \$3 million to universities and research firms in the United States and Europe.

Grants.
University of Miami, Coral Gables, Fla.—\$1,157,100 for laboratory-based theoretical research in fluidity, stability.
University of Wisconsin, Madison, Wis.—\$774,100 for the theory of magnetohydrodynamic flow for the study of astrophysical phenomena.
University of California, Berkeley, Calif.—\$1,157,100 for the study of turbulent convection in solids.
University of California, Berkeley, Calif.—\$1,157,100 for the study of turbulence in fluids.

Contract University, Washington, D.C.—\$1,157,100 for theoretical research on turbulent flow, stability, and boundary layer flow.
University of California, Berkeley, Calif.—\$1,157,100 for research on turbulent flow, stability, and boundary layer flow.
University of California, Berkeley, Calif.—\$1,157,100 for research on turbulent flow, stability, and boundary layer flow.
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CUT COSTS WITH THE ONE UNDERWING NOZZLE DESIGNED FOR ON-SITE MAINTENANCE—THE NEW BUCKEYE #13460!



To replace major valves, disassemble nozzle for tube layout, rotate collar to top bracket, push down and rotate exposed assembly in flow.



Rot major valve, rotate collar—left and right and hold rotating support assembly from the nozzle.



Back on the job in less than 10 minutes, delivering maximum flow at minimum pressure drop, zero flow, instant shut-off. Nozzle is light, efficient, sturdy and dependable. All required valve functions can be done "on line" for true long range economy.

For what you could save. Write for details on prices, configurations and accessories, too.

BUCKEYE IRON & BRASS WORKS, Box 882, Dayton 1, Ohio

Buckeye

RAYTHEON AT WORK

New Raytheon radar-TV helps FAA give added security to air travelers

Every time you or your loved ones travel in the U.S. by commercial plane, that flight comes under the watchful radar eye of the Federal Aviation Agency's new "bright display" system. Now the FAA can look, day or even night, absolutely certain to see "bright display" equipment developed by Raytheon.

The FAA's air traffic control system—which has long included Raytheon radar units—provides the safety of our travels by keeping a close check and accurate record of the speed, course and altitude of planes in flight. And this new "bright display"—one of 60 installations—gives the radar operator a valuable new tool for monitoring air traffic.

Conventional radar pictures, for example, show each aircraft on a single screening map on the screen. In the new system a Raytheon image tube collects these individual maps and presents them as a series of a clearly visible "rank grid" of each plane's exact progress and position. The picture is sharper and brighter than before television.

When the FAA completes this network of "bright display" control stations, it will make our travel safer than ever... another example of Raytheon clearance duty at work on behalf of better understanding, service and defense. Raytheon Company, Lexington, Massachusetts.

RAYTHEON



Objectivity

If you're tired of hearing about the "perfect" printed circuit connectors, you're just the man we want to talk to.

We're here to offer you freedom of choice because that's where objectivity begins. The boy blowing his last penny on candy wants to be able to choose between the 10-sealed delicious and the stuff that lasts all seasons. It's licorice versus probenbers, root-beer-banana versus bubble gum. They're all good, but none are perfect.

That's why we make such a variety of printed circuit connectors. Each type and style has its own special believick. They're all "perfect" when they're applied properly.

ONE NEW BELLOWS-TYPE

Take the new Amphenol 225-series. The bellows-type connector has the smoothest, quietest, most efficient mating action you'll find anywhere. From after decades of innovation, the delicate, conductive surfaces of the printed board are safeguarded by the 225.

The 225-series has remarkably low contact resistance too. For the solder terminated style, it's under 25 milliohms at 5 amperes.

The bellows-type connects on the 225-series is split down the middle. You get two contact points for every interconnection. That helps keep the contact resistance low, of course, but it also conforms readily to irregular mating surfaces.

The 225 is convex. It needs and mates the printed circuit board with a wiping action that ensures contact.

AND, FURTHERMORE

The 225-series contact is self-sealed in the connector body. Con-

tact faces will not distort at the slightest pull on the terminals.

The 225-series has twice the flexing range that you'll find on other bellows-type connectors. That means you can neck the board twice as far with no danger of contact distortion.

The 225-series does not waste valuable connector space with a polarizing key. The key is embedded in the bellows contacts.

The 225-series can be terminated with solder tags, tape guns, removable crimps, or Wan-Wan® terminals.

Contact style? Contact position? Mating provisions? Well, let's just say that there are over 100,000 combinations available in the Amphenol 225-series bellows-type connector.

WHO NEEDS IT?

And now for the facts of life. Some people simply don't need the 225-series. Some printed circuit boards are inserted once and never detached again. Some printed circuits are never subjected to pull on the terminations. Some printed circuits are not really so delicate that they must be protected from contact wear. Some printed circuit boards never get necked. And in some applications, the space taken up by a conventional polarizing key is of no consequence. And so forth.

And that is why Amphenol makes Pin-Cor® connectors, Micro-Edge® connectors, Micro-Mate® connectors, and specials that haven't been named yet. They are all printed circuit connectors. They are all "right" where the need dictates their use.

The hero of this story is the Amphenol Sales Engineer. He's the only man who has access to a complete

AMPHENOL Connector Division

line. That's why he's the only man who can look you in the eye and tell you exactly which printed circuit connector you need. Objectivity.

You won't hear Amphenol Sales Engineers telling you about perfect connectors. They don't have to. They know better.

DETAILS MATTER

If you're really interested in seeing what a complete line of printed circuit connectors looks like, we invite you to write for our new 20 page catalog PC-1 that contains your local Amphenol Sales Engineer, or write to Dick Hall, Vice President Marketing, Amphenol Connector Division, 1830 South 56th Avenue, Chicago 58, Illinois.



Problem: To make contacts that give an extremely low millivolt drop, yet do not wear printed circuit conductors, wear after thousands of insertions.

Solution: Believed contact faces for easy contact. Double spring action with wide flexing range. Then double plate and patch to smooth they slide on the mating surface.

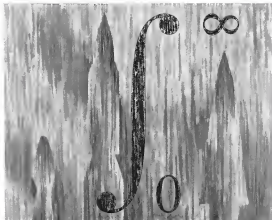


Aerospace planners find themselves with a number of potential vehicle designs for any given mission. To avoid the astronomical dollar expenditures testing even a few of these would entail, industry has devised mathematical procedures that do the big job of weeding out the poorer designs. (3) Douglas missile and space systems mathematical simulation programs are among the most advanced and comprehensive in operation today. The company's researchers have developed a variety of procedures that "figure out" hyper-

MATHEMATICAL MISSILES

...AND WHAT DOUGLAS IS DOING WITH THEM

sonic vehicles in the laboratory. "exhaust" configurations to increase heating and loading environments...even outdoor "battles" between missiles. Another aid is a unique Douglas viewing system which allows relationships between various parameters (trajectory, et cetera) to be observed in three dimensions



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DOUGLAS

AVIONICS

USAF Seeks New Microcircuit Techniques

By Philip J. Klein

Douglas-Air Force's microcircuit research and development program is directed toward developing new materials and techniques for an advanced generation of microcircuits and to applying similar concepts to design and equipment opening of microwave frequencies.

Four years ago, the USAF Electronic Technology Laboratory (ETL) has opened the microcircuit revolution by awarding contracts to Westinghouse Electric and Texas Instruments (AW Apr. 27, 1959, p. 54). Today, these are over a dozen microcircuit suppliers, not counting in-house facilities.

Improvements in current microcircuit costs are caused by natural competitive forces and do not require Air Force backing, in the view of Dr. H. V. Noble, ETL's technical director.

ETL Budget

For the moment, ETL is spending its modest \$4 million Fiscal 1963 budget, and plans to spend a similar total in Fiscal 1964, to explore more advanced materials and techniques which in future otherwise might not pursue work its own funds. In Fiscal 1965, ETL hopes this new technology will be ready for USAF opening of development of specific microcircuit functions leading to commercial availability of advanced functions.

A breakdown of current and planned Fiscal 1964 microcircuit programs, according to Richard Alberts, chief of ETL's molecular electronics branch, shows:

- One-third of the total program is devoted to exploring new materials and processing techniques for microcircuit technology.
- One-third is aimed at applying a microcircuit functional concept to devices or subassemblies operating at microwave frequencies.
- One-third is directed at investigating basic new materials, such as organic compounds, which have application both to semiconductor devices and to microcircuits.

USAF has found that one of the best ways to advance microcircuit technology is to sponsor development of specific pieces of "microcircuit proof" hardware, according to Alberts. This forces the microcircuit and equipment designers into close liaison, requiring, each to learn more about the specific needs and capabilities of the other.

Presently, this results in an entirely new microcircuit function which the equipment designer would not otherwise know could be accomplished and which the microcircuit designer otherwise would not know was needed.

For example, a contract to Texas Instruments to design and build an all-microcircuit telemetry receiver has resulted in the development of two new types of microcircuits, one an operational amplifier and the other a differential amplifier.

Another such "microcircuit vehicle" contract has just been awarded Texas Instruments to design and build an electro-optical digital computer. Preliminary computer studies aimed at this objective have produced an optical multiplexer switch with near-perfect isolation between input and output and multiplies other voltages in low as a few microvolts, Alberts says.

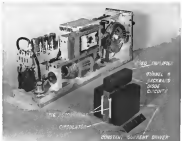
Westinghouse Electric presently is building a microcircuit version of an airborne infrared search-track system for delivery early next year. Presently, Westinghouse has built a microcircuit CMT transceiver, the AN/ARC-65, under ETL contract. Motorola recently received an ETL contract to design and build an all-microcircuit digital communication system.

The molecular electronics branch has a daunting task on hand of its budget to research and explorative development in the microcircuit end of the spectrum, which has been largely ignored previously, because of the large potential payoff in size, weight saving and improved performance. The ETL program includes all types of solid-state techniques that can be used to perform functions which presently require discrete or electromechanical techniques.

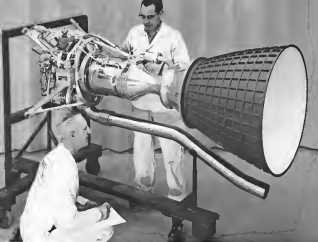
Microcircuit Tunes

Lead Electronics Co., for example, is developing an integrated solid-state microwave tuner as part of an existing electronic communications receiver-tuner which needs a complex electromechanical linkage, to sweep over the operating frequency band. Where the conventional ECM tuner requires 50 sets of coils to sweep over the band from 7 gc (giga) to nearly 11 gc, the new solid-state tuner is expected to sweep the same band in only one sub-second.

Where the electro-mechanical tuning band portion of the conventional ECM receiver weighs 195 lb and occupies 1,093 cu in, the new Lead solid-state tuner is expected to weigh only 21 lb.



AIR FORCE IS APPLYING solid-state functional circuit concepts to microwave equipment, such as communications receiver-tuner. Lead Electronics is the one company expected to be the size of the working design. Solid-state ECM tuner being developed by Lead Electronics, is smaller, lighter, more sensitive and can scan band more rapidly.



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Titanium's compatibility with ceramics makes rugged, light-weight parts for ultra-high temperatures

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Take a look at the modified nozzle extension on the Agros. According to

Bell Aerospace's Company, who designed and built the Agros engine, a base of titanium shell coated with aluminum oxide was able to save 30 pounds over the original copper-coated graphite part. Yet it was able to give equal heat treatment and at the same time provide a significant increase in strength and ability to withstand rough handling.

The uncoated titanium ceramic nozzle extension has increased nozzle area more than 100% over the previous model contributing to an improvement in specific impulse and engine performance. The titanium Agros engine has become the workhorse of the Air Force's Starline Program, the Ranger, Minuteman and other NASA programs.

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and average only 41 mV (see photo p. 8). Power consumption for this new device is expected to be only 31 mW, compared with 300 mW for the conventional unit. In addition to these attractive size, weight and power savings, Alberts predicts an important gain in reliability due to the absence of moving parts in the new design.

Increased Sensitivity

Another feature of the solid-state tuner is the fact that because it contains a tunnel diode RF amplifier—where the conventional tuning head has only a passive tuned coil—the new device is expected to have vastly increased sensitivity of -122 dbm compared with -68 dbm, according to Alberts. This is equivalent to a 125-fold increase in distance at which signals can be detected.

Additionally, the new solid-state device will include microcircuit video amplifiers and a barium-dielectric video detector. These eliminate the need for a transformer and in the conventional design which is as large and costly as heavy as the tuning head, Alberts says.

The new solid-state tuner will use silicon gate process (VLSI) technology where energy dissipation can be changed by varying the strength of the magnetic field applied to the material, preventing electric tuning of the device.

Other ETL-sponsored programs at the microwave field include a contract with Varian Associates for the development of a distributed tunnel diode oscillator which might be used to replace klystron tubes. Also, Microwave Associates is investigating the P4N type diode for use as a power switch and perhaps as an oscillator.

ETL Programs

Programs which ETL is sponsoring in the area of advanced generation semiconductor technology include the following:

- Hybrid semiconductors, using thin-film deposited metals, oxides and/or dielectrics deposited on a semiconductor substrate, are being investigated by Motorola. The company is drawing the line of the thin-film technology toward developing thin-film devices and processes which are compatible with materials and techniques used in fabricating silicon semiconductors. Hopefully, the hybrid thin-film/semiconductor microcircuits could be fabricated in a continuous process without extensive out-of-vacuum handling. Materials which Motorola is investigating include tin oxide and niobium for resistors and aluminum nitride for use as a capacitor dielectric.

- Active thin-film devices, in which passive elements can be fabricated from the same material used to make active devices, is the objective of an extensive



MICROWAVE VHF RECEIVER operating at 2130 Mc built, was built by Westinghouse Electric Co. from semiconductors and active microcircuits using company funds. The receiver (top) includes a tunable input and an output with the results are shown in a 5-MHz display.

ETL, an initiative, a program sponsored at Electro-Optical Systems, Inc., Pasadena, and a new one is to be developed very shortly. Efforts to date have been based on tunnel diode technology, simple which do not require processing at present, Alberts says. The new program is expected to explore insulated-gate, field-effect transistors, also called metal oxide semiconductors.

- Deposited thin-film single crystal beds on semiconductor and microcircuit materials (except substrates) is under investigation with ETL sponsorship. Schottky is looking to deposit active films and germanium devices on a glass ceramic substrate, while Leon Segler is working with gallium arsenide and silicon dioxide deposition on semiconductor substrates.

- Adaptive circuit elements which select various elements are being investigated by Stanford University. It is possible to use in self-selecting computers and routers. Earliest device developed by Stanford, an electro-optical one known as a "memristor," changed its resistance by electro-optical action in response to "read" or "program" signals applied to the device. A more recent Stanford development is a magnetic core element which has much more rapid response (nanosecond) time and does not deteriorate with use.

- Low-frequency acoustic amplifiers, consisting of a cadmium-sulfide crystal with piezoelectric crystals attached to either end, has been replaced by Texas Instruments, without two cracks across its date, Alberts says. However, during the course of this program, it was discovered that cadmium-sulfide which acts as a control element at low-current levels will break into sections when the

applied voltage is returned to normal value. This may open the way to a new type of solid-state oscillator.

- Organic materials electronic functions are being studied by Texas Instruments and RCA companies, in the hope of developing rugged semiconductor devices and microcircuits. The interest in organic stems from the fact that it is the easiest to manipulate and contains the most characteristics. If organic semiconductors could prove feasible, this would open the door to what could eventually be called "molecular electronics."

Since the beginning of electronic technology, equipment designers have been faced with the same problem: possible number of active devices (diodes, transistors, etc.) by substituting larger numbers of cheaper passive devices to reduce overall component count.

The advent of microcircuits, a changing of this particularly with semiconductor microcircuits, where the cost of fabricating an active device is consistently the same as that for a passive device. It, therefore, becomes cheaper to use a minimum number of active devices of each active element can replace several passive devices.

Basic Circuits

Thus, however, represent the development of entirely new network analysis and design techniques. For this reason, ETL is sponsoring a program at the University of California at Berkeley. Its research has been carried out from that high viewpoint, with emphasis placed on maximum use of active devices.

While ETL sponsors, however, that the microcircuit technology has moved faster than the other, might have predicted five years ago, they emphasize that problem areas remain.

One is internal heat dissipation with semiconductor devices that can be solved in microcircuit construction, according to ETL's William Spaul. Another is the problem of electron microcircuit—both interconnection of individual elements on a single substrate and interconnection of a substrate with other substrates to form a complete system.

Spaul says that methods must be devised to eliminate bonded wires which are so widely used in present microcircuits and connect them to the outside. One of the most promising techniques is to sputter gold bonding into the passivated silicon substrate to connect internal wires to a terminal around the circumference of the substrate to which outgoing connections can be welded.

Eventually, a partial solution to the problem of microconnecting individual substrates (microcircuits) into adapt-



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ties will cause low impedance micro-current manufacturing processes. This will permit fabrication of larger numbers of components and circuits on a single substrate with good yields, according to Edward Stenroos, chief of the integration techniques section at RTL.

Improved Microcircuitry

The new technology, which uses die-bondless substrates, also may apply to the fabrication of integrated quality microcircuitry, according to Stenroos.

Another possible solution to the interconnection and interconnection problem is the use of electro-optical contact junctions in which small beams of light provide the mechanism for signal flow between elements of the microcircuit.

The division in Lincoln Laboratory has said that a gallium-arsenide device would most reliably deliver energy when coated by a voltage bias quaternary (VTL) circuit in electro-optical technology, particularly for digital functions such as comparators.

Although gallium-arsenide and other semiconductor materials and materials are now routinely processed, gallium-arsenide compounds can be made to operate in laser, emitting coherent light (VTL) present effects in liquid or their use in incoherent light contacts.

Semiconductor Materials

Because semiconductor materials have both light-emitting and photoconductor properties, it should be possible to fabricate an electro-optical flip-flop within a single crystal. When a voltage is applied to one junction, it would emit light which would activate the other junction, allowing it to conduct current.

Several months ago IBM announced the development of an optical transistor in which light serves as the charge carrier between junctions.

This suggests the possibility of being able to fabricate a number of tiny light-coupling junctions and photoconductive junctions within a small piece of semiconductor material, with no interconnections provided by light.

Flow of light within the crystal to desired positions might be controlled by application of electric fields and not at separate regions. Albert and Electro-optical digital computer which Texas Instruments will design and build for delivery next summer.

will also work as a research vehicle to evaluate new optical computer techniques and develop suitable computer logic.

There will not be any attempt to include such multiple functions in a single crystal.

One of the most promising potential advantages of an electro-optical computer is the ability to achieve high chemical isolation between input and output, permitting extremely high laser (semiconductor) light. This, in turn, should permit the construction of a microcircuit but parallel-queue type computer.

The diode light source has extremely rapid turn-on time, on the order of one microsecond (10⁻⁶ sec). But one of the rapid switching time is limited at present by the conductivity slower response time of photoconductors, but there is hope for improving on performance.

An Air Force-sponsored comparison of solid-state light generation at Lincoln Laboratory has resulted in the discovery of a new method of solid-state phosphors.

Texas Instruments also is conducting research on light emission under ETL control.



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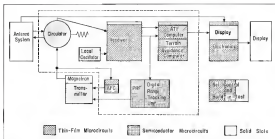


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EXTENSIVE PLANNED USE of semiconductor in Autonetics' lightweight ground mode radar, the XR 45, is reflected by showing at each major block in this simplified block diagram. Solid-state portions are indicated by shaded portions of each block employing particular component part groups. For example, radar receiver will be composed principally of thin-film semiconductor, the remainder being one- and two-terminal solid-state components. Magnifier and display tube are the only non-solid-state electronic parts in the system.

Autonetics Designs Advanced Radar Line

By Barry Miller

Autonetics, Cold-Advanced line of airborne navigation and attack radar intended for low-level, ground-mode missions should feature high-performance military aircraft is being designed and developed here by North American Aviation Autonetics' Avionics Control Div., using extensive computer analysis as a direct aid in design.

The new radar is being built with repeated use of about 50 different microcircuits, thereby cutting the number of process steps by a factor of 130. This enables possible lighter manufacturing controls which is expected to shrink costs and lower reliability.

Autonetics also is borrowing technology such as computer analysis and prediction of component and circuit behavior employed so successfully in its Air Force-sponsored, \$110 million Minuteman ICBM high-reliability parts replacement program (AW Dec. 12, 1968, p. 95) and is applying them in the extremely crowded field of airborne radar. The company is planning, for example, to replace in its new side-radar system eight of the 19 basic semiconductor microcircuits now in the early phase of development for possible use in the improved Minuteman program. The primary objective of this component-oriented effort is airborne radar systems which are more reliable, more easily maintained, lighter and less expensive.

This goal coincides with the increasing requirements for future military missions external. Like Navy's VAX lightweight Light Airborne Attack Radar (AW Apr. 1, p. 95).

Autonetics currently is in the midst of breadboarding two versions of new ground-mode radar. One of these is the XR 45, a multi-mode, pulsed system having clutter mapping, high and low altitude ground map, terrain avoidance, automatic terrain following and air-ground ranging capabilities. An airborne search mode can be added. One version of the XR 45 is being proposed to its leading avionics management contractor is the VAX computer. Another version has been proposed for the Integrated Helicopter Avionics System (IHAS). Other possible applications identified by Autonetics for this family of radar include the VAX VAX (VAX/VAX), the CX-45, the Northrop F-5, the CX-4 COIN aircraft and Army's new surveillance aircraft. Second group of radar is the XR 47, a single mode, pulsed automatic terrain following radar. This family is designed to be a single mode radar which can be equipped with a current mode for terrain avoidance. It is intended for those applications needing an ATP capability. These would include backup to an existing radar while testing this capability, in addition to a radar like the APQ-72 on the McDonnell RF-4C which built the ATP capability, and for use in low-day

missions like the North American GAM 77.

The XR 45 will weigh less than 100 lb when assembled, including a passive radar, including and associated drive equipment, according to Autonetics. This compares with a weight of between 250 and 275 lb. for a comparable system employed in current high-performance operational military aircraft. The low complex XR 47, on the other hand, will weigh less than 15 lb. More than before (Autonetics) for the multi-mode system, Autonetics also, will be in order of magnitude greater than the MTBF of the comparable operational system, which has an MTBF of between 40 and 50 hr. The MTBF design objective of the XR 47 is several orders above that of the XR 45. Confidence in its ability to attain these goals is based on its Minuteman experience, the use of microelectronics and the use of computer in circuit design. The design objective for the microelectronics is a 10-year shelf life and a three- to four-year operating life.

To reduce the present 14 to 15 lb maintenance requirement for each hour of flight time of some airborne radars, a major effort is under way to simplify maintenance and replacement along with increasing reliability. Both radar families are modular in construction with assemblies at various levels adapted separately in plug-in containers. The module level for the XR 47 (see photo p. 91) corresponds to specific



MOCKUP OF AUTOMATIC TERRAIN FOLLOWING RADAR, the XR 45, one of two families of lightweight airborne navigation and attack radar being developed by Autonetics' Avionics Control Div., is shown. This model ATU weighs less than 100 lb. Its plug-in modules corresponding to gross radar functions are indicated in different colors. Thus the receiver and display are removed from one of two modules of automatic terrain following computer. Flat plate electronically scanned antenna (right) is integral part of radar mount assembly, the main side of the solid unit.



functions such as the ATU computer (two modules), the radar receiver, the transmitter, the power supply and the magnifier.

Since these six plug-in parts, they can be repaired on the flight line by less skilled personnel than in flight situations. Faults need not be corrected by a control system and maintenance steps similar to the Air Force control guidance facility at North Ohio.

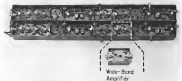
The radar is being designed to eliminate field adjustments or "patching" of individual circuits. This will be accomplished with components whose variations in time will not exceed tolerance permitted by the circuit. A spaceworthy module procedure has followed in the Minuteman program. On the basis of computer analysis and accelerated life tests the variations in parameters are grouped over a three-year period and only those components whose values would be expected to be within allowed limits at the end of the period are used.

In the Minuteman case the stability of individual parts at the end of three years actually exceeded expectations, according to Dr. William F. Wahl, chief engineer for advanced engineering of Avionics Control and former head of the Minuteman reliability program. With transferred to his present position about a year and a half ago and being(s) will have several key people, from the Minuteman program, including Raymond J. Senneker, now directly involved with design of the new radar.

From component and circuit in the radar programs undergo extensive computer analysis. Typically, each circuit is analyzed as a computer with components simultaneously correlate computer results with working bandwidths. The open circuit current for each active element is coded on the computer by ensuring that its gain characteristics match

those observed with the broadband detector. If a discrepancy occurs, a new model which will match the observed gain characteristics is accepted. Circuit parameters and loads are continuously varied and gain characteristics repeated to observe effects.

Not the end of the design run, this a variable event has evolved a Monte



ADAPTIVE USE of the most types of circuits throughout XR 45 is illustrated in block diagram of two-channel plug amplifiers of radar receiver—excluding steps from IF amplifiers through detectors. Note that each three circuit types are employed here (above). Broadband of the step using conventional components is shown (below) with a separate flat-plate electronically scanned antenna corresponding to use IF amplifier.

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Microminature Airborne Computers

Western, Calif.-based Elgin's microminature airborne digital computers, one version of which was proposed in the current Navy competition for an integrated avionics package for the Y-12 fighter, was developed here recently by officials of Avionics Div. of North American Aviation, Inc.

One device, the Mission C, is a basic clock rate control computer with a 3,200 30-bit word random access core memory capacity. An additional analog core memory has a 150,000-bit word capacity and a clock time of 1.5 microseconds. Main memory cycle time is 0.5 microseconds, and access time is one third of this. The main memory can be expanded to 32,768 words.

Mission C logic and memory drive systems will employ 3,000 1/2-in. transistors—transistors equipped with semiconductor microcircuits—now in development for it. These will be packaged in flat 1-in.-x-1-in. packages mounted on both sides of multi-layered printed boards.

The machine's add time is 4 to 12 microseconds, its multiply time is 10 to 40 microseconds, and divide time is 100 to 1000 microseconds. It will weigh 25 lb., occupy 0.5 cu. ft., and require 170 w. First computer-qualified flight test is planned for June of next year.

A second computer, the Mission I, intended for navigation, guidance, flight control and radio communications, is a somewhat simpler and smaller machine. A typical computer of this type will weigh 10 lb., occupy 0.15 cu. ft., draw 50 w., and have a 1,024 12-bit word capacity. Like the new Avionics today (see story), it will use the first semiconductor microcircuits now being developed for the Avionics K-100 guidance computer system. First flight of this system, according to the new plans, will be in November.

Each program is two. Each component is the exact in size over its expected statistical distribution of characteristics. The computer program simplifies the distribution 500 times, in effect building the circuit 500 times. In this fashion, circuit behavior is observed and a complete experience of variation is produced—circuits or not, in observed.

In the circuit design, an emphasis is being placed on feedback errors where the rate of component values becomes more important than individual component values.

Microminute Use

An essential element in the design of the new radar will be the extensive introduction of microcircuits. These will reduce the number of processing steps, in both the plans of the radar which apply some microcircuits, and at Avionics.

Moreover, the processing steps, be a factor of 100 percent circuit control in manufacturing according to West and results in rapid of tolerances and reduction in cost.

Semiconductor microcircuits are given top priority for use whenever they are applicable and are expected to be available within the time span of radar equipment development. Microcircuit semiconductor microcircuits are to be developed because their design will be the combination of such computer system and thus are expected to benefit from increased level reliability and manufacturing knowledge.

The design will reflect a blending of semiconductor and then the microcircuit and conventional solid-state com-

ponents. The only non-solid state parts will be the transmitting modulator (vacuum tube) and a duplexer tube.

Semiconductor microcircuits appear even more prominently in the radar's frequency digital portions of the radar, such as the digital range tracking unit, the pulse repetition frequency counter, the target indicator computer and possibly in the automatic target tracking unit. Where there are low frequency logic circuits in which the 4-wire semiconductor microcircuits can be used, this is again achieved, as in the first microcircuits, which require solution of individual tolerances and delays. In higher frequency portions of the radar that are assembled in microcircuits, such as the 60-wire receiver chain from the RF amplifier through detectors, then the microcircuits appear with some discrete components. In general, microcircuits are used wherever possible. Where they cannot be used, conventional solid-state components take precedence, but potentially less reliable moving parts and vacuum tubes.

Frequency Bands

Both radar families can be designed for operation in different frequency bands—X, K, K, and C—and using the appropriate equipment and substituting a suitable RF head (oscillator, mixer and local oscillator).

As in the more Navy Y-12 systems competition, where Navy stressed need for a reasonably strong competitor—whether the competitor is a radar or a radar system—Avionics is using a reduced number of circuits repeatedly throughout its radar systems. This

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consistently permits more thorough design on fewer errors, thereby reducing the overall development costs, according to Robert E. Hinds, chief of advanced components at Avionics Control. It would also simplify testing, maintenance, replacement and repair.

System Components

The XR 45-Went prints out, will contain about 70 different microcircuits—eighteen semiconductor types earned over from Minuteman and 12 to 15 thin-film types. This represents a sensible reduction in circuit types from earlier units, a typical one of which might have 15 or more designs for so common a circuit as a cathode follower. A single circuit follower (thin-film microcircuit with diode trimmer) will be used for impedance matching function in these new radars to replace the various cathode followers.

Of the eight semiconductor microcircuits, three are linear—a power output modulator/driver/amplifier and a general-purpose amplifier. The first digital types are a control flip-flop, counter flip-flop, gate, logic and sampling hold circuit. Typical thin-film circuits include an RF amplifier, preamplifier, video amplifier, center follower, oscillator, ramp generator and oscillator.

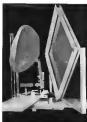
Thin films being used include resistance resistors in values up to 500 ohms per sq, normally homocirc in the 100 to 200 ohms per sq range. Resistive tolerances of 5% can be tolerated in 1% by the use of exposed conductive design.

Capacitors being used in one plate, electron mode in a diode and aluminum in the second electrode, will vary up to 0.01 microfarads/sq. in. Auto wires had developed new detectors using blends of silicon oxide and rare earth materials which have higher dielectric constants, enabling possible a gain in ratio of 5 to 10 microfarads per sq. in. Ceramic substrates are used to take advantage of their good heat conductivity.

Vacuum Evaporation

Vacuum evaporation processes are being developed with the objective of reducing possible thin operations in a single evaporation of insulators, conductors, dielectric and capacitor electrode. Capacitors probably will be fabricated in separate steps, however, to preserve purity in the operation.

Vacuumists also had been doing thin film work, making small circles 4 cm in diameter in value of 2 microinches. Micro transistors and diodes for thin-film microcircuits probably will be packed up in mechanically sealed TOSI cans. The interdigit circuit, which is not a direct part of the radar, also will use a hybrid combination of semiconductor



EXPERIMENTAL compares various systems for possible use in XR 45 airborne radar unit in inserted parallel dish which returns RF energy received from land and ocean to against reflecting plane which can turn and rotate toward 90 deg. The latter changes polarization of signals and reflects them back through the parallel dish microcircuits and conventional components.

Avionics says that reduced testing, repetitive use of a smaller number of common circuits and the reduction in ground steps will be responsible for a sizable cost savings. While reluctant to put a specific price tag on new units in other funds, it does indicate that the XR 45 will sell for somewhat less than \$10,000 compared with about \$25,000 to \$75,000 for a typical existing jet control system.

Antenna Design

A number of unusual antenna designs are being explored for possible use in XR 45 systems. Although a parabolic dish is the usual radar choice, actually this new technique (see photo above) uses a type of stacked parabolas in a composite dish. RF energy fed into the several facing parabolic beam former is reflected back against a reflecting plane on which is located a one-wavelength spaced grid which is tilted 90 deg. This changes the plane of polarization of the signals which then can be reflected back through the parabolas. The system permits scanning ± 60 deg in azimuth, ± 70 deg in elevation.

Other features of the XR 45 include a self test—Problems in being made for detecting low voltage, impedance, frequency signals into the microcircuit of the equipment between transmission and receipt of pulses during flight as a self test antenna. Responses are now proved with prepared selection of the ATP problem and should show less discrepancy, the benefit will be pro-

grammed for an automatic pickup. The pilot also will have a manual switch with appropriate selection for making ground checks in each mode.

• **Reduction** in size, weight and power: All components are situated in a cabinet rated for accurate cooling. Air ducts provide for passage of cooling air.

Photographs of the XR 45 nacrop indicate some of the simplifications in hardware which have resulted in substantial weight savings. The radar antenna is a flat plate, electronically scanned screen which is part of the mounting structure. This type of antenna has characteristic areas and only one scanning post, an on-board high-powered plane shifter, remains. Electronic weight has been halved by using microcircuits and accounts for only 6 lb, about 20% of the radar's total weight. Cabling and cooling systems also were reduced, in some those of the power supply and an oil-cooled state transmitter.



• **Monitors ASR/TAR** Radio-Scall as transparent radar seen atop the island of the USS Kestrel during a recent MAAP speedoff review was the new AN TTN-6, an extremely light-weight combination air surveillance and precision approach radar developed by GAF.

• **Computer Translates Chinese**—Experimental criteria for automatic machine translation of Chinese to English has been demonstrated by International Business Machines Corp. System, developed under Basic Air Development Center sponsorship, enables a non-Chinese speaking operator to monitor 6,500 different Chinese characters using a typewriter keyboard in which three lines must be struck, in sequence to define one character. System capacity can be expanded to handle 35,000 characters or more. IBM says.

• **EIA Makes Airframe Survey**—Quarterly market survey of the avionics industry has been undertaken by Electronics Industries Ass. to obtain data on factors which inhibit and advance progress during calendar year 1963. Types of avionics equipment for which data will be sought include communications, navigation and guidance systems, communications combinations, flight control and guidance, radar, test equipment and miscellaneous parts, such as radio altimeters and flight recorders. EIA seeks participation of all avionics manufacturers including manufacturers of the aircraft. Individual companies should be contacted for more information. EIA advising overall industry trends.



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powder, wire and rod products...

METAL POWDER—Tungsten and molybdenum metal powders of 99.95 minimum purity are available from General Electric for almost any application requiring these metals in powder form. They are produced by the hydride reduction of high purity compounds produced by chemical purification of tungsten ore and molybdenum trioxide. Intrinsically free of tramp elements, they can be used for the following steps back to these basic starting materials in a key to high quality.

Hydrogen reduced tungsten metal powder is available in a wide range of sizes. For example, you can get it in an average particle diameter (as measured on the Fisher Sub-Sieve Sizer) of less than one micron and all the way up to 50 microns. General Electric tungsten metal powder can be made to any reasonable sieve size. Carbide, nitride, and oxide coatings... plasma spraying... these are applications well suited by G-E tungsten powder. Want a high pressed green strength powder where your pressing pressure is limited or you can't use a binder in your melt? Have resistance to leakage or abrasion? General Electric has one that's best to use in your application, such that a sintered powder is not required? General Electric can probably custom produce one for you.



WIRE AND ROD—Tungsten and molybdenum in the form of wire and rod are basic products of General Electric. With an historic leadership of supplying wire for our own electric lamp filaments and

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Tungsten, offered in self contained coils or as spools, is available in wire in sizes from 0.002" through 0.200" in diameter. A General Electric 12" x 0.002" wire (tungsten/95, tungsten) is available for critical jobs in vacuum and electronic tubes. Tungsten rod is supplied in straight lengths in sizes from 0.004" through 1.000" in a chosen finish and through 0.200" in a ground finish. For automotive catalysts, with their hard jobs, ballistics and other interesting applications, Tungsten rod in the form of electrodes for tungsten rod (T90) welding are G-E products, too.

Molybdenum wire is supplied in the diameter range from 0.002" through 0.200". This product is "drawn" molybdenum with a chloride stress relief and is shipped in self contained coils or as spools. Moly rod, shipped in straight lengths is supplied in diameters from 0.002" through 1.250" in either a cleaned ground finish flat diameter size or annealed, too.

2" x 8" TUNGSTEN/MOLY SNEET & PLATE WITH DESIGN HORIZONS

General Electric scientists and engineers have designed new processes for rolling tungsten and molybdenum into molybdenum sheet and plate, up to two feet wide. A series of new rolling mills has been designed specifically for the flat rolling of refractory metals. Now fully installed and operating, they give General Electric unique capabilities in the supply of tungsten and molybdenum up to two feet. Where can you use only refractory metal in your design? Now you have complete data.

CAPSULE SPECS FOR FLAT ROLLED PRODUCTS				
PROCESS	FORM	TYPE	PURITY	AVAILABILITY
Single strand, electrolytic	Flat	Plasma metalurgy Recurrent anneal	99.95% min	Mo: 99.95%—0.9995% through 0.001% W: 99.95%—0.9995% through 0.001% Tungsten—0.9995% through 0.001% Molybdenum—0.9995% through 0.001%
	Sheet	Plasma metalurgy Recurrent anneal	99.95% min	Tungsten—0.9995% through 0.001% Molybdenum—0.9995% through 0.001%
	Plate	Plasma metalurgy Recurrent anneal	99.95% min	Tungsten—0.9995% through 0.001% Molybdenum—0.9995% through 0.001%
Molybdenum, electrolytic	Sheet	Recurrent anneal	99.95% min	Tungsten—0.9995% through 0.001% Molybdenum—0.9995% through 0.001%
	Plate	Recurrent anneal	99.95% min	Tungsten—0.9995% through 0.001% Molybdenum—0.9995% through 0.001%
Tungsten, electrolytic	Sheet	Plasma metalurgy	99.95% min	Tungsten—0.9995% through 0.001% Molybdenum—0.9995% through 0.001%
	Plate	Plasma metalurgy	99.95% min	Tungsten—0.9995% through 0.001% Molybdenum—0.9995% through 0.001%

*Operating at 1000°C

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THICK WALL TUBES AND CRUCIBLES—General Electric can make straight, long, uniform tubes from the center of PS Moly or PS Tungsten. The size of the tubes are available in O.D. sizes up to 32 inches. Maximum I.D. for any given length is three quarters of the O.D. Thicker walls may be available by machining. Lengths to 30 inches depending on diameter. PS Tubes are used to furnace incandescents, electrodes in vacuum arc melting, mobile hardware and other applications. General Electric's unique hydrostatic pressing technique lends itself to crucible forms, available in O.D.'s up to 12".



VACUUM METALLIZING WIRE AND FILAMENTS—General Electric tungsten

has an important role in the vacuum metallizing industry. It is an electron beam source for evaporating metals in high vacuum. General Electric "Long Grain" tungsten is supplied in vacuum metal stock in the form of filaments for the



metallizer who prefers to buy his tungsten ready-to-use, or in the form of threaded wire for users who prefer to make their own filaments. General Electric films this kind of tungsten in the form of tape sheet, open strand and aluminum in coil strand for columbium results in metallizing. If you vacuum metallize, be sure to specify General Electric tungsten. Write for the tungsten metallizing wire and filament catalog.

IMPORTANT PHYSICAL PROPERTIES OF TUNGSTEN AND MOLYBDENUM

	TUNGSTEN	MOLYBDENUM
chemical symbol	W	Mo
atomic number	74	42
atomic wt. (A)	183.84	95.94
melting point	3410°C (6170°F)	2620°C (4750°F)
boiling point	5627°C (10150°F)	4912°C (8860°F)
density (solid, 20°C)	19.3 g/cm ³ (0.69 lb/in ³)	10.22 g/cm ³ (0.37 lb/in ³)
electrical resistivity (room temp)	5.5 x 10 ⁻⁸ Ω-cm	5.5 x 10 ⁻⁸ Ω-cm
thermal conductivity (room temp)	170 W/m ² °C	130 W/m ² °C
expansion coefficient (room temp)	6.5 x 10 ⁻⁶ /°C	6.5 x 10 ⁻⁶ /°C

Below data: Solid content: 99.95% (solid content: 99.95%)

Write today on your company letterhead for a useful Tungsten/Moly Converter and Weight Size-Unit Calculator (free) and complete product data files on tungsten and molybdenum. Write to General Electric Co., Lamp Metals and Components Department, EN 21800 Tungsten Road, Greenville, SC 29615.

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RCA Memory Stacks, temperature-controlled within ±2°C are designed to meet MIL Specifications. Available in conventional or high density packages, these stacks can be utilized where specifications call for conventional core operation over extreme temperature ranges (up to a 120°C span).

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RCA conventional memory stacks may be used where temperature extremes are not a critical problem, but where RCA's high quality and reliability are required at lowest possible cost. Hundreds of these stacks are now in use with an outstanding record of reliability.

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MODIFIED HFB 320 two-pot executive aircraft shows high T-tail with blended body and pit ports enveloping wing roots. Wings have been swept forward 15 deg. Note that landing gear housing has been cut off under the wing.

HFB.320 Modified to Boost Performance

By Warren C. Wetmore

Hanburg, Germany—Wind-tunnel testing in four nations—Germany, the Netherlands, Spain and Switzerland—has caused a number of modifications to be incorporated into the latest design of Heinkel's Flugzeugwerke HFB 320.

"Hansa" two-pot executive aircraft. Changes reflect the company's desire to boost performance while maintaining a competitive price in the crowded executive jet market.

Production schedule has been maintained despite these changes which have been effected since the first design details were announced last year (AW Nov. 14, 1962, p. 131). Reflect of the

fact of two prototypes is slated for next October, to be followed by testing and shorted take-off tests prior to the first flight near the end of November.

Most apparent modification is the incorporation of new riling in conjunction with turning of the fuselage-mounted main landing gear housing. The alteration was made after 1/16-scale model tests were conducted at the transonic tunnel at the NLR, both tests in Amsterdam.

Measurements of local static pressure taken in the wing were also carried out at this facility.

Less obvious is the replacement of the two all-wooden Pratt & Whitney JT17A-6 turbojet engines contained in

the original specification by General Electric CJ610-4 engines.

A Heinkel's Flugzeugwerke official cited the following reasons for this change:

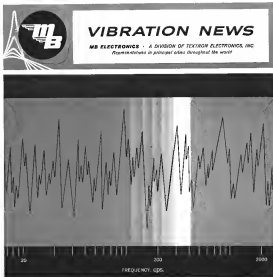
- Lowest cost of the CJ610-4—amounting to more than \$10,000 per engine—for approximate the same performance.
- Lower specific fuel consumption than the JT17A-6.
- Greater thrust-to-weight ratio for the GE engine.

• Size of the GE engine is smaller, both in cross-sectional area and in length.

Adoption of the 2,600-lb thrust CJ610-4 resulted in a redesign of the under-fuselage, main cabin and wing—and floor plates. Engines now



THREE-VIEW of the HFB 320 shows several design modifications, including new riling and fixed closed engine nacelles and pylons. Outboard landing-gear shift has been eliminated and horizontal fin has been added to the wing tip tanks.



MB introduces SWEEP RANDOM— a new, low-cost method of random vibration testing

MB Electronics now offers industry the Narrow Band Sweep Random system. This new technique in random vibration testing is designed to create stresses and accelerations at all levels similar to those provided in the more expensive wide band random test. It is easy to operate and inexpensive enough to be used with the standard simulation test systems in general use today.

The new MB SWEEP RANDOM method reduces the total force required for wide band testing by sweeping slowly over the frequency range with an intense narrow band excitation, in contrast to the low acceleration density excitation of the wide band test. This results in a reduction of three one third to one half the force output level when required for identical random vibration tests. Con-

siderable cost savings are also realized with this new MB system. The MB SWEEP RANDOM system is ideally suited for testing components and sub-assemblies of systems which might be given a final qualification test by wide band random techniques. For more detailed information on the SWEEP RANDOM system write to MB Electronics, 781 Whalley Ave., New Haven 8, Conn.

are heated further from the facility, a modification which Harbridge Engineering will add to its flexible program soon at the option.

Harbridge further says the wing about midline between root and tip has been added in the current design and, for simplicity, the damping also on the outboard leading edge now defined. Inboard leading edge data have been refined, however, as well as the splices located at about 1-chord on the upper and lower surfaces of the 15-qt-diameter wing. Double-chord tips on the trailing edge are available to 10 day for tapered and 60 day for leading.

Optional Series

Company plans to include other optional high lift devices as later production aircraft. These devices will be made available in high lift or cruise lift.

Over-all length of the 111-3,320 has been increased from 31.4 ft to 34.3 ft for added stability. Height is now 15.6 ft, compared with 14.5 ft in the original design.

Enlargement of the tip radius to 112 1/2 ft to increase the aircraft's range in combination with U.S. aerial refueling needs resulted in a forward shift of the center of gravity. This has been accomplished by offsetting the deck-wing effect of the large tanks and to device spot built-in automatic weapons on the wings. This also will act as fuel storage, according to the company.

Capacity of the 158-gal. central fuel tank located between the two wing spans passing through the fuselage behind the passenger cabin is unchanged, but that of the integral wing fuel tanks has been reduced to 257 gal. each. Although offset of these wings is to be used, the total fuel weight now 6,545 lb to 7,345 lb and the maximum take-off weight from 16,514 lb to 17,640 lb.

Increased Range

MB's range for 111-3, right to the top of the range has increased to 1,672 mi., with capacity for a 95 mi. dimension flight time 30 min. holding at 20,000 ft with 1/2 of the fuel for reserves on landing. Calculated 111-3 range with under reserves was 1,490 mph in the original design.

Revised maximum speed also is higher—475 mph, as opposed to the 340 mph cruise speed for which the 1,490-mi. range was calculated in the original design. "This" cruise speed for the 12-passenger turbofan configuration is now quoted at 340 mph, as against 314 mph.

Service ceiling of the aircraft with both engines operating is 70,000 ft at a weight of 15,410 lb.

Other work items involved in test

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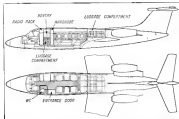
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OUTWAY AND SECTION VIEWS of Hansberg Flugzeug HFB 320, a two-passenger composite that serves load of the cabin, including the 40-cu-ft baggage compartment in the rear. Seven-passenger version was on display at the Paris Air Show.

ing the HFB 320 design include those at the Max Planck Aerodynamik Research Institute (AVR) in Göttingen, Germany, the Swiss Federal Government facilities at Kempten, and the National Aeronautics Technology Institute (INTA) in Madrid.

An airborne refueling system, stability testing, and a partial engine are also under construction. Hansberg Flugzeug plans to conduct 15,000 hr of endurance testing at up to twice the normal pressure differential—11.5 psi—the equivalent of 32,000 to 33,000 ft—long term.

Storing Tests

Tests on a full-scale functional model of the HFB 320 fuel system are under way, and parts of the structure have been tested with regard to clearance, stiffness and rigidity. Heat isolation for the cabin and doors is also has been investigated.

General Electric will conduct 150 hr of tests on the Saucier variable-orifice-type thrust reverser, which will be optional equipment.

In addition to General Electric, the other HFB 320 subcontractors include:

- Fokker (Amsterdam)—wing design
- Nickel (Darmstadt)—wing production
- CASA (Madrid)—comps, flap and aileron
- Hispania Suiza (Paris)—landing gear and hydraulic system
- Flight Refueling (Blandford, England)—fuel system

Final design construction at Hansberg Flugzeug's main plant here is nearly complete.

Company estimates that the total cost for the development of the HFB 320 through the first flight tests will

be \$4.85 million, of which approximately 20-25% will be borne in varying amounts by the subcontractors and suppliers.

Hansberg Flugzeug still is hoping for official government support in the form of a slice of the \$7.4-million German Federal Republic budget appropriations earmarked for subsidizing aircraft research, design and prototype fabrication. The measure is said to be making "good progress" as the Bundesflug, lower house of the West German parliament, but it is not yet known whether the funds will be available before the end of the year.

Finally, price of the HFB 320 is currently quoted at \$565,000 to \$695,000—depending on the optional equipment desired—of 130 are produced.

Final Orders

To date, three firm orders for the aircraft have been received, all from private companies within Germany, and others are being negotiated. Several non-European air forces are said to have expressed interest in the HFB 320. Hansberg Flugzeug has been negotiating with the U.S. Federal Aviation Agency, and its German counterpart, the Luftfahrtministerium, for certification of the HFB 320 as the two countries. Certification tests will be conducted at the German Aerospace Research Institute (DLR) in Bonn, says.

Delivery of the first production aircraft is scheduled for the end of 1984, which will probably be later than such potential rivals as the Dassault M500 and the McDonnell DH 125.

European sales of the HFB 320 will be handled by the Taurus Group, which has facilities in Germany, Bel-

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Burns and Roe, Inc., New York, is studying the feasibility of three types of mobile nuclear powerplants to determine optimum power level, evaluate technical problems and to assess cost factors involved with advanced base plants, diesel central units for shipyards and beachhead plants for combat use. Study is sponsored by a \$91,000 Navy Bureau of Yards and Docks contract.

Bell Helicopter Corp. has been awarded a \$4,615,934 Army contract for production of 150 OH-135 light observation helicopters. The contract resulted from competitive negotiations with Bell and the Helix Aircraft Corp. for an off-the-shelf aircraft.

Spectra-Physics, Inc., won a \$155,000 contract from Goddard Space Flight Center to provide instrumentation for a magnetic field component test facility, to go into use in about a year. Facility is to be built around a three-axis Resonant rod that will compensate for the earth's magnetism to within 0.001%.

General Electric TP400 turbojet engines for the North American R570. Each 3-recommanced-aircraft bomber has been run for 3,500 hr under actual and simulated altitude operating conditions up to 70,000 ft. Of the total, 960 hr were at conditions above 50,000 ft. Future of the aircraft is a double (AWW May 30, p. 20).

Garrett Research, Los Angeles, will develop a one-man environmental control system, for use as a Gemini passenger transport, for McDonnell Aircraft Corp. The \$300,000 contract calls for delivery of three of the environmental control systems.

Bendix Corp's Bendix Pacific, 100 North Hollywood, Calif., will modify the flow control valves and actuating cylinders for the Air Force B-58 Hustler under a \$2.5 million contract from General Dynamics Corp.

General Positioning. Ray's Information Systems Group will supply additional anti-airborne warfare computer systems for weapons control, under a \$1.5 million contract from U.S. Navy.

Firebird Camera and Instrucon Corp. will build panoramic camera systems and stabilized mounts for the RF-4C reconnaissance aircraft under contracts from McDonnell Aircraft Corp. totaling over \$2 million.



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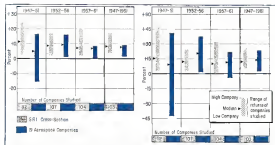


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FINANCIAL



COMPARISON OF AEROSPACE INDUSTRY profitability with non-defense companies is tabulated by Stanford Research Institute in terms of total assets (40) and return on net worth (left). Total assets are those shown on the assets side of the balance sheet, with depreciation and prepaid payments excluded. They do not include government-owned property or leased property. Arrows point to median levels (the values at the center of 100 aerospace companies in the 1940s to the 1950s non-aerospace firms). This shows the spread between the top and bottom companies. Ratios on total assets indicate a lack of spread between profitability at the top and bottom aerospace companies and the closeness of the top firms to the median. The non-defense companies (labeled here) are a sample selected by SRI, and all are among the top 100 U.S. corporations. Most of the 19 aerospace companies (labeled here) are also included in the top 500.

Report Cites Industry Reliance on Leasing

By William H. Gargery

Changing complexion of the aerospace industry, as depicted in an Aerospace Industries Assn. sponsored study, reflects two sets of potential financial significance: lengthening allowable periods and increased use of leasing.

Of the two, which has a close-to-the-fact relationship, the use in leased facilities, and equipment has been reduced less, but may have more long-term implications to the financial strength of the industry.

Growth of leasing has been encouraged by an amendment to the Armed Services Procurement Regulations covering allowable. Lease payments are an allowable cost. Interest payments are not, which might be used to purchase facilities or equipment, say not.

The detachability of interest payments may offset this advantage somewhat. Even so, the industry's use of leasing appears to be mitigating one potential debt financing in the industry's capital structure.

Assessment of the real significance of leasing in the industry's financial profile

is not as easy as doing so for other capital items because usually only annual total payments are shown in financial statements. Debt, however, is shown as a specific item on the balance sheet, not only in terms of payments due within one year, but also in the aggregate with maturity dates.

Nonetheless, leasing often represents substantially the same kind of obliga-

tion as debt, including interest which is contained in the annual scaled payment, and the full measure of it needs to be included in any analysis of the industry.

Difficulty of analyzing its impact lies in the lack of any formal accounting system for treatment and because the lease payments may represent a relatively short-life piece of equipment—like an industry leased jet engine being

AEROSPACE MANPOWER COMPOSITION 1947, 1955, and 1961

	1947	1955	1961
Total manpower in activities surveyed*	50,340	111,671	399,164
Direct employees as percent of total	77.2%	75.2%	74.4%
Total contract employees as percent of total	22.8%	24.8%	25.6%
Engineers and scientists (qualified as percent of total)	12.3%	9.6%	14.3%
Other skilled employees	12.3%	14.2%	20.3%
Technicians as percent of total	9.6%	4.0%	4.1%
Technicians per 100 engineers and scientists	20	42	37

* Aerospace companies reported manpower data for 12 months ending in 1961, 12 months of the same companies reported comparable data for 12 months ending in 1955, and all of the same companies reported comparable data for 12 months ending in 1947. Source: Stanford Research Institute.



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smoothed, in effect, over seven years to a building with a useful life of 20 years.

Because of the instant information available, the insurance technique as applied to the aerospace industry is to capitalize annual rental payments at an advance rate. The Stanford Research Institute study sponsored by AIA developed such estimates on which reported and privately supplied data of 13 aerospace companies. Using capitalization rates of 14% and 10%, the study estimated average total rates of lease equipment for the 1957-61 time period at \$350-\$750 million.

In another analysis, using data from 12 aerospace companies to make up a composite profit and loss statement for the years 1955, 1959 and 1961, the study estimated increases in interest and lease payments as a percentage of sales. This showed:

	1955 vs. 1959	1959 vs. 1961
Total Interest	+122.0%	+171.0%
Total Leases	+208.0%	+207.0%

	1955	1959	1961
Total	\$2,010,000	\$31,980,000	\$36,000,000
Interest	1,000,000	4,000,000	10,000,000
Leases	1,000,000	4,000,000	10,000,000
Cost of sales	1%	4%	4-5%
Interest	1%	1%	1%

TAXES REPORTED PAID BY A GROUP OF AEROSPACE COMPANIES

(alliance of Boeing)

Year	Federal Taxes*	State and Local Taxes
1949	\$63.71	\$19.0
1950	17.9	19.0
1951	20.2	19.0
1952	22.5	21.1
1953	24.8	23.2
1954	27.1	25.3
1955	29.4	27.4
1956	31.7	29.5
1957	34.0	31.6
1958	36.3	33.7
1959	38.6	35.8
1960	40.9	37.9
1961	43.2	40.0

* 18 companies, 1949-61: 14 companies, 1952-61. Manufacturer-General Electric, Boeing, Lockheed, North American, Republic, Ryan, Douglas Aircraft, Convair, Fairchild, Grumman, Hamilton, Hughes, Martin, McDonnell, North American, Northrop, Republic, Ryan, Ryan, Sperry Gyroscopic, and United Aircraft.

* Not adjusted for refunds of excess profits tax imposed by abolition of the five percent of the United States. Source: Derived by Stanford Research Institute.

These figures show that both interest and rental payments are growing in significance, especially since 1955. This could be expected as a natural consequence of the government policy, by gaining in the late 1950s of acquiring more capital investment by the defense industry and of acquiring the industry to assume a greater element of risk.

Perhaps less obvious is the fact that interest payments, despite their greater percentage increase over the period, are a smaller absolute amount of industry financial activity. Furthermore, growth of total payments appear to have ac-

celerated faster after 1955 than interest payments have.

The real significance of the growth in leasing is to be found in the effect leasing has on the total capital structure of the aerospace industry.

Stanford's study does not deal directly with this question. Its estimates on leasing were developed along with more for the value of government support utilized by the aerospace industry for demonstrating the viability of its acceptance of aerospace industry activity with probability of non-defense manufacturing.

(Continued on p. 127)

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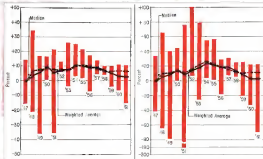


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RETURNS ON TOTAL ASSETS for selected years shown (left) and on net worth (right) for the 51 aerospace companies analyzed by Stanford Research Institute. In addition to the returns levels, the average return in each category also is plotted, weighted to adjust for the differing size of the companies in the sample. Number of aerospace firms in the Stanford study varies because of the differences in available data and the use of companies as a major category within the industry.

These returns are shown in the tables on p. 115, with the greater emphasis in the study on returns on total assets, a method not commonly used in previous concentration on the profitability of the defense business. As indicated in the tables, companies' returns are generally less than that of one defense company. This is true whether on a median basis—that is, the halfway point in the list of companies—or on a weighted average basis that puts more emphasis on the results of larger firms.

As a matter of considerable significance, the weighted average figures in the study tend to fall below the median, showing relatively lower profitability of the large companies.

Evaluation of the importance of the growth in leasing is dealt with in fuller detail in another study of the aerospace industry distributed at about the same time as the AIS report. This was done by the Arthur D. Little Co.

Admittedly, the figures must be approached with caution because of the expense of mobile information and because of the various possible terms, conditions and types of leasing. Even so, the Little estimate does not seem out of line, based on a 51-company sample, against the Stanford Research figure based on 12 or 13 companies. Interspection of the significance of a growth in leasing consequently is subject to qualifications.

In the Little study, the leasing out-

lets is complemented by a set of assumptions of the value of the industry's use of government facilities—assumed to have a net total value for the 51 companies of \$2,345 billion in 1956 and dropping to \$1,782 billion in 1960—and of progress payments by the government on contracts. (The Stanford Research estimate for gross value of government property employed by 51 companies is an average for the 1957-61 period of \$1,170 billion.)

Estimated value of government and

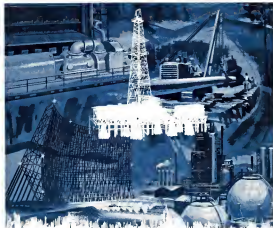
lease-owned property was added to a 75-company corporate income sheet and theoretical earnings on government property are added to a composite profit and loss statement to attempt to adjust for the added return the industry presumably would earn on such property if it was privately owned.

Adjustment also is made to discount interest cost from earnings that would be required if the government advances were obtained from private lenders. Results of all these comparisons

COMPARATIVE RATES OF RETURN ON NET WORTH FOR 19 AEROSPACE COMPANIES AND SELECTED SERIES 1957-1961

	19 Aerospace Companies		Selected Series (weighted averages)			
	Average	Weighted Average	644 Core Series	500-500	Fort Hallmark City Series	Fortune '500'
1957	14.2%	16.2%	12.2%	12.2%	12.2%	13.1%
1958	12.7	13.8	8.4	8.5	8.4	10.2
1959	10.0	8.0	10.8	10.8	11.4	9.8
1960	11.6	7.7	10.2	9.1	12.4	11.0
1961	11.0	7.4	10.8	9.7	12.1	9.4
1957-61 average	11.8	8.8	10.8	9.4	12.8	11.0

* Weighted average earnings computed by aggregating earnings and net worth for the entire period.
Source: Derived by Stanford Research Institute.



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show that profit margins are likely to exceed 15-18%—from a published 1.8% in the SEC/FTC survey for 1961 to 2.1% suggested with an all-industry average of 4.9%. On net worth, however, the ratio for 1961 runs from 9.7% to 10.6%, which is above the all-industry average of 9.5%.

While that is an interesting statistic, the fact is that government officials are not likely to be much concerned about rate of return percentage points so long as the industry is willing and able to deliver weapons under the present rules of payment of procurement. The lesser profit margins of the industry, in effect, translate as a cost for use of government facilities and advances.

More significant is the change in another way in the assumed balance sheet—debt/equity ratio. This figure runs from an actual .18 in the 11-company survey for 1961—that is, 29 cents of debt for each \$1 of equity in the form of common or preferred stock as in issued savings—to 1.18 on the basis of assumptions.

Although businesses like the defense one and its record a 1:1 debt/equity ratio, the usual standard considered as safe by lenders is a 1:1 maximum for manufacturers, and the actual level for SEC/FTC all-industry survey was .15.

Two conclusions can be drawn from this analysis:

- Financing requirements of the defense industry will increase markedly if government policy continues to demand more and more industry investment in facilities.

- Increased equity financing as a result of the potentially high debt/equity ratio is likely to be necessary, and with the industry's relatively low return it is open to question whether the private capital will be available.

The Little study does not consider the industry in the trouble, but does say that it is trending on dangerous ground. A change in AFPR to double buying costs would have an obvious deep impact on industry's earnings.

While the government is not likely to deliberately let the defense industry collapse, with the consequent endangering of national security, there is danger that the government will fail to recognize the danger signals in time, the Little survey says.

With internal civil government from expenditures also low, the Little study warns of potential trouble for the industry in the 1970s.

Ignoring the question of government property, the debt/equity ratio for the industry using the prevailing buying estimates is considered as 75. This level is high, though, again, not unheard of for manufacturing companies.

As long as defense and space spending remains high, as they show every signs of doing, the industry can doubt

can carry the obligation. But the industry wants a serious question as to the effect of a major reversal of this trend—a private disarmament program, for example. Not only would a sudden shift in defense spending affect the defense industry directly, but the impact would transmit itself through the lending and leasing in the case and eventually reverberate through the entire economy.

The impact of the entire question of allowable costs on the industry is not widely kept in military circles, the Standard study indicates, but it does have a more significant use when con-

sidered to earnings. Most important is the growing trend toward increasing the list of allowable expenses in light of the government's drive for contractors to assume a greater share of capital burdens.

No specific amounts are given, but for 15 companies which provided data to Standard Research as the basis, cost disallowances were from 3% of total sales in 1953 to 35% in 1960.

As a percentage of pretax earnings, the average rose from 5% to 14% from 1953 to 1958. Presumably, the companies whose business was primarily defense had less cost disallow-



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MANAGEMENT

McClellan Group's Reaction Mixed On Rubel Procurement Proposals

Washington—Central question in the current discussion of military procurement reform is whether there is a better way to develop the information the secretary of defense needs to select the best bid.

Focus of the discussion is a memo released within last August by John H. Rubel, former deputy director of the office of defense research and engineering and since moved to the Defense Industry Advisory Council. The memo was discussed June 6 by the Senate Permanent Subcommittee on Investigations in connection with its probe of the F-111 (TFX) tactical fighter contract award (AV June 18, p. 37).

The major change under the memo would be to eliminate military source selection boards that now recommend to the defense secretary who should get the contract. The military source evaluation groups, which now report to the selection boards, would still continue to function. But they would only analyze proposals, not make any recommendations as to who should be awarded the contract.

Subcommittee reaction to the proposal ranged from apprehensive to sympathetic, with Chairman John L. McClellan (D-Md.) and Sen. Edward S. Muskie (D-Me.) representing the poles of those viewpoints. Sen. McClellan and the recommended procedure was called Section 227, Title 10 of the 1950 Armed Forces Act, which states that in an aircraft design competition, military source selection boards shall recommend winners to the defense secretary.

Sen. McClellan also expressed concern about language in the so-called "parent memorandum" that Rubel wrote to Deputy Secretary of Defense Russell L. Galpin. "It turns out in practical terms," Rubel said in his memo, "to be difficult if not impossible to alter a source selection decision on a major procurement when unless you are willing to send the source selection board back to work with new instructions. Otherwise, you are placed in the position of making an arbitrary change in the face of a fully objective procedure and determination. That is, in general, undesirable. It is very time-consuming and it exposes the source selection mechanism to potentially severe criticism and even outside pressures. It is practically never done."

Sen. McClellan said he did not want

to take any power away from the defense secretary, "but I am equally opposed to relegating the military, the fighting men, the people on whom we must depend as the final analysis for our defense of our country—choosing their own ranking and contribution to that decision."

Just eliminating them to a position of no voice or vote, even if it doesn't amount to anything," Sen. McClellan commented that military advisory boards named by the defense secretary would not be as valuable as a formal military source selection board.

Sen. Muskie said and Rubel agreed—that unsanctioned reforms were designed to bring "to the attention of the top decision-maker the alternatives which were previously debated at some lower echelon of the department to that the top decision-maker himself can also understand the alternatives as well as soundness of the final recommendation which has been submitted to him."

Sen. Henry M. Jackson (D-Wash.) and he are concerned that eliminating military source selection boards might upset the system of checks and balances as fundamental to the governmental structure.

The Defense Industry Advisory Council reviewed the Rubel memo recently at its meeting of May 3-4. The memo was presented by a special subcommittee, consisting of Rubel as chairman and members C. B. Farnum, chairman of Lattin Industries; William M. Allen, president of Boeing; and Thomas Janz, president of Northrop Corp. After the F-111 controversy erupted, Allen offered to resign from the subcommittee but then might be a conflict of interest. But Rubel and both he and Galpin persuaded Allen to remain. Allen is the son-in-law of the secretary of the subcommittee who favors the present source selection procedures over the proposed one. There is wide support within the 23 member panel for the recommended change in the system.

Besides concern among military source selection boards, the fact that of the Rubel memo as presented to the Defense Industry Advisory Council, representatives tell us, leaders ahead of time the report to be accepted to deliver, explaining to the unsanctioned leaders how the winner was chosen, giving some conditions latitude in affecting their subcontractors



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so does will have more chance of obtaining the accurate positions of the contact, and establishing of the deflection section's, pleasure—speed—advisory boards to analyze the differences in competing proposals. High reliability often could be appreciated as these all have boards.

There are the highlights of the final subcommittee report.

• **Building costs.** Permitting extremely large numbers of builders to compete for extremely long periods in extremely varied of reliable, insurance, especially, source technical manpower resources.

Top-Level Judgment

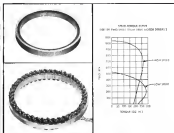
• **Decision time.** The source selection procedure should not, of and be, itself tend to extend decision time unnecessarily. Procedures which once begun, must be carried through to completion almost unilaterally and then started all over again at further refinements or modifications are rejected, are extremely time-consuming. Worse, therefore exclude the extreme of impartial judgment and place a barrier between source representatives of the Defense Dept. and of industry which impedes or interferes with achieving that meeting of minds to consent to the effective discharge of long-range commitments and responsibilities.

• **Partnering competition.** The manner in which sources are selected plus a major part in creating that market place and influencing that degree to which the values cited here receive proper emphasis. The criteria that are used in judging competition are key factors in shaping the actions that are taken, both by the source and by the government. It is essential, therefore, that the principal criteria used in evaluating bidders shall be known both to those who compete and to those who will evaluate the relative merit of the bids and bidders. Inclusion of requirements to defense needs can be mutually enhanced if suitable evaluation criteria are established, pre-ordained and utilized throughout the source selection process.

Final Decisions

• **Selection responsibility.** "Evaluation should not be equated with selection, and recommendations should not be made in a context which gives them the force of final decisions."

• **Defining scope.** It is essential that the scope and content of each selection action be carefully defined in advance. What is covered by government source selection actions and what is not? What should be the relationships among prime contractors and major subcontractors? A major source selection which, for example, places heavy weight upon the formation of a successful con-



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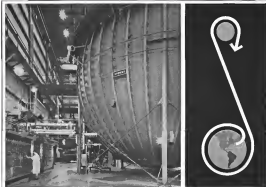
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most processes by the prime contractor must allow for the creation of key subcontract relationships consistent with that requirement. Government procedures must be consistent in this regard—prices are to be incentive contracts, policies cannot be applied which dictate or restrict the choice of subcontractors in a way which makes incentives meaningless or impossible to meet. Likewise, when actual prime contractors are to be considered on a single project, selection procedures and documents must permit the selection of all bidders in order and not in rotation out from under.

• **Screening bids.** Each bid would not require very much preparation, but they would require the company to have some staff with the general objectives of the proposed program and to have vital statistics concerning the company's capabilities, vision, intentions and past experience and performance on projects comparable in technology and complexity. The screening phase is concerned with capabilities and intentions, not with proposed solutions to the particular project. The proposed system and the approximate relative weight to be given to them should be made known to the bidders during this phase.

The process would narrow the field to no less than three nor more than eight bidders.

• **Organic bidding phase.** During this stage, the bidders would be expected to arrive (but not to delineate) their proposed technical solutions and approach, along with their incentive proposals with respect to cost, performance, quality and cost. The bidding phase would not be considered as a standard for acquiring a large volume of low design information. Neither the specifications used as basis for bidding, nor the bid materials themselves, should be issued either by industry or by government in the last word in establishing the character and defining the scope of the final program.

• **Evaluation group.** The evaluation and the composition of the evaluation board would be largely unchanged from present practice. The evaluation board (which can be viewed as a major procurement) must be set up to accomplish evaluation and evaluation only, not selection. A key point concerns the involvement of the appropriate entities to be used by the evaluation board. These criteria and their relative weight should be established by the evaluation board before requests for proposals are sent to industry for the bidding/gatekeeping phase. These criteria, as no have noted earlier, should be made known to the industrial community.

The usefulness of the action taken by the evaluation board will depend

largely upon the criteria that are adopted by the board as a basis for their work. It is important to recognize that these criteria can be made more useful if they are two broad, and will be of greatly diminished value if they are too specific. In any case, the results of the evaluation board must be subjected to consideration, scrutiny, and tested for the effects of government.

It is essential that the broad criteria be clearly understood by the evaluation and by industry alike, but it is equally important that these should not be treated as an inflexible basis for a merely numerical appraisal of the bids. If the evaluation board were to utilize

such a numerical procedure in deriving their results and making their views available, this should be due to do that in a strictly internal procedural manner. However, it is equally essential that such procedure, if employed by the source evaluation board, should not become identified with the selection process per se. It is essential that post and cost, supplied by clarifying organizations, be set forth in an integral part of the evaluation. It is also essential that the final value, as derived from a more numerical view, should be assessable and should be reported, not necessarily by the evaluation board (although they may have a contribution

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Navy Hydrofoil Tested on Puget Sound

Navy's gas turbine-powered research hydrofoil Frick 1 (Foil Research Supercavitator Hydrofoil) reached more than 60 mph during a speed test run on Puget Sound. The craft, built by Boeing, is making up to runs of 90 mph with its present hull system. Ultimately, the craft is expected to reach speeds of 120 mph, Boeing says.

so much, but certainly by the responsible agency."

• **Advisory board.** The colonelmaster and the individual service secretaries and defense secretary may wish to name a senior defense advisory board to assist in evaluating competing proposals for a major contract. The board might be strictly military officers or include civilians.

"Above all," the report said, "the advisory board needs to be a working board. It must assess the results presented by the secretary by the evaluation board—the advisory board is not there merely to ratify or to examine recommendations of the evaluation board."

The advisory board should prepare a written report for the secretary. The report should outline the principal objectives at which the issue solution was aimed. It should describe the pertinent highlights of the history antecedent to the current evaluation process and present the principal options that were established in evaluating proposals. It should outline the activities of the evaluating board and summarize their principal findings. Finally, the advisory board should describe the manner in which it has assessed these findings, and it should present the principal interesting alternatives for decision. Agencies of the board in support of and in opposition to each alternative, and the effects of perturbations of criteria and assumptions used in evaluation should be presented.

"Finally, the secretary of the military department should be able, to use the report of the advisory board in arriving at his decision, consulting with members of the board, and where necessary, with members of the evaluation board to develop action necessary to clarify his understanding.

"The essence of this procedure is to present options in the context of comprehensive and complete information to

the secretary of the military department. The objective is to avoid the opposite of this to avoid creating a recommendatory board, based upon a very elaborate scoring process, fortified by recommendations made through a long chain of command, which it can, in practice, be difficult to overturn. Certainly the secretary of each military department ought to seek the advice of his principal military and civilian advisors and advisors—but the process used to accomplish that advice must not, of and by itself, virtually amount to making the decision."



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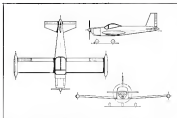
For information about your opportunities in the Electronic Equipment Division at McDonnell, complete and mail, in confidence, the brief resume form below. For a comprehensive, immediate review of your qualifications, attach a complete resume of your education and experience.

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Siat 223, shown in three views, has control-reload wing and interchangeable control surfaces. First prototype is under construction by Siebelwerke-ATG GmbH.

Siebelwerke Building Prototype Of Siat 223 Aerobatic Trainer

Duesseldorf, West Germany—First prototype of the Siat 223 aircraft, two-seat trainer built by Siebelwerke ATG GmbH, a member of the Bolkow Group, is nearing completion here. Aircraft is scheduled to begin flight trials near the end of this year.

Present design conceived in the winner of a competition sponsored jointly by the West German Ministry of Economics and the German Aero-Club in 1961 for a standard training and sport three-seater.

The Siat 223 is a fully aerobatic and suitable for towing gliders with a gross weight of up to 950 lb. Further development of the aircraft had been suspended since 1961 because of the lack of government funding. Growing interest in the West Germany for an inexpensive, non-instrument light trainer resulted, convinced Siebelwerke that it should proceed with development of the prototype, at least, with company funds.

A few days for the Siat 223 has not yet been held, but Siebelwerke says it expects to market the standard model for approximately \$8,000.

Final decision as to whether the Siat 223's production, the first Siat 223 designed primarily for sport and business flying (AWM No. 30, 1960, p. 98), will ever go into production is still pending. Tough competition in the light aircraft field—particularly from the light three U.S. aircraft, Beech, Cessna and Piper—may make it difficult

to enter market the original Siat 223 design considerably as soon as it enters a company aircraft sale. Following climb CAA Part 3 specifications governing the design of both "normal" and "ultra" class light aircraft, the Siat 223 is a conventional low-wing monoplane structure with a basic loading gear.

To cut production and maintenance cost as well as hold the factor's structural requirements to a minimum, many of the aircraft's construction parts are interchangeable. The radio, for example, can be fitted to form one half of the electronic assembly. The left and right ailerons can be interchanged, as

can the flap wings. The nosewheel and main landing gear wheels also are interchangeable.

Powerplant is a single four-cylinder, air-cooled Lycoming O-320-A1A engine rated at 158 hp, driving a fixed or optional variable pitch propeller. When used only for normal training purposes, the aircraft can be fitted with a 185 hp Lycoming O-325-C powerplant.

The Siat 223's rectangular wings have no center span joining through the fuselage.

Fuselage is an all-metal, monocoque structure. Cockpit, with side-by-side seating, is fitted with dual cable controls plus a sliding seat that allows all-round visibility.

Beech, Piper Report 6-Month Sales Increase

Two major light aircraft manufacturers—Beech and Piper—reported increased sales for the six months ending May 31, and one—Cessna—reported a decrease.

Beech Aircraft Corp. reported sales of \$34,843,112 compared with \$31,508,667 for a corresponding period in 1962. Net earnings were \$1,100,028, down from \$1,161,035 last year at the same time. Reduction in earnings—which dropped from 49 cents to 41 cents per share—was attributed to starting costs in new production programs.

Beech directors declared a regular quarterly dividend of 15 cents per share, payable May 8. Of the company's total sales, \$23,149,595 went to commercial customers and \$11,693,515 to the military and aerospace industry. Last year commercial sales were \$16,368,619 and military and aerospace sales were \$12,895,898.

Cessna Aircraft Co. reported total sales of \$44,917,000 for the six-month period ending May 31, compared with \$48,253,000 for the period in 1962. Net earnings were \$1,897,000 or 66 cents per share in 1963, compared with \$1,116,000 or 95 cents per share in 1962.

Decline in sales was attributed to a drop in military orders, which sharply dropped more than \$1,800,000 in the year. However, military backlog at May 31 stood at approximately \$21,600,000, compared with \$15,000,000 at the same time in 1962.

Piper Aircraft Corp. reported sales of \$17,516,537 for the six-month period ending May 31, 1963 compared with \$16,119,506 for same period in 1962.

Net income amounted 51%, from \$987,115 in 1962 to \$995,145 in 1963. Income per share increased from 68 cents to 91 cents.

Siat 223 Specifications

Engine	158 hp Lycoming O-320 A1A
Wing span	27.2 ft
Length	22.5 ft
Height	6.5 ft
Wing area	120.5 sq ft
Aspect ratio	6.41
Empty weight	975 lb
Useful load	725 lb
Gross weight	1,680 lb
Max speed	128 mph
Cruise speed	124 mph
Takeoff speed	85 mph
Rate of climb	16 ft/sec
Service ceiling	16,400 ft
Range	682 mi
Wing loading	117 lb/sq ft
Power loading	17 hp/sq ft



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At Lockheed-California Company, a team of engineers and scientists currently is engaged in an intensive study of flight and operational characteristics involving America's first Supersonic Commercial Air Transport (SCAT). These studies include evaluation of flight and wind tunnel data to determine performance criteria and mission capabilities of tomorrow's airliner.

Planned to operate on the fringes of space, SCAT presents many unique problems. The solutions are doubly important, since they involve factors of practical application to airframe conception. Advanced conceptual studies are also being carried on with V/STOL, access, hypersonic fighter aircraft and right-rotator helicopters.

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International Atmospheric Study Urged

By Rodrick D. Hobbs

National Academy of Science is proposing a major international cooperative study of the atmosphere as a world-wide effort to advance the state of atmospheric sciences.

The study would be an attempt to combine the high level of international cooperation and collaboration achieved during the International Geophysical Year (IGY) and carried through the planning phase of the upcoming International Year of the Quiet Sun (IYQS). Development of a worldwide system of meteorological services was recommended as the overall goal at the International Year of the Quiet Sun (IYQS) Committee on International Programs in Atmospheric Sciences and related areas under the Geophysics Research Board.

The report spelled out the following technical advances which should be sought to facilitate the meteorological research:

- Development of balloons with improved operating characteristics and lifetimes. Many developments could increase balloon operating altitudes up to 100,000 ft, while operating altitudes of 150,000 ft could be expected in the near future.

- Meteorological sounding rocket systems and launching networks which could provide measurements in the area between the operating altitudes of meteorological balloons and satellites.

- Instruments capable of operating in manned high-altitude aircraft and rockets with minimum sampling altitudes of 50 mi which do not require launching from established launch ranges. Efforts also should be made to reduce the cost per sounding rocket launch from \$2,000 to \$500 and rockets should be made of reusable material to eliminate hazards over populated areas.

- Improvement of sensing systems which don't require precision radar and high speed computers for data reduction.

- Reduction of raw data and reduction processing equipment into radioisotope systems and development of optical scattering techniques for night observations to obtain temperature, density and atmospheric composition profiles. The measurement of these profiles, reported at intervals of 1 mi or longer, appears feasible using pulsed laser light scanning systems costing about \$50,000 per unit. Development cost for the entire radioisotope system was estimated at \$250,000.

- Improvement of radar to probe

autor trails 10-55 mi high and to record density and aerosol changes in the wind temperature and density of those altitudes. Radar system capable of viewing these studies would cost about \$50,000 per unit.

- Establishment of a meteorological radioisotope network with launches at night. Two-month networks. Weekly and bi-weekly launches capability would be desirable. Procurement and operation costs of each radioisotope station for two years were estimated at \$140,000. Flight package, tracking and scheduler development, using ground-based radars, would cost \$1 million.

Close coordination with related geophysical fields, particularly oceanography, was urged by the Academy's committee, since there are many energy exchanges and interactions between the oceans and the atmosphere.

Lead aim of the program will be to cover specific problem areas in atmospheric sciences of both practical and scientific importance which would demand greater collaboration between

governments. The proposal stressed it "neither possible nor desirable to specify particular technical problems that should be attacked by specific groups," however, since traditionally and naturally scientists carry out research according to their own interests and those of their governments.

Concern for the atmosphere is a national scientific and with the effect of atmospheric processes on human activities has increased in the report and five broad interdependent groups of atmospheric sciences activities were proposed. They include:

- Research on weather prediction.
- Modification of weather.
- Study of the high atmosphere (cosmosphere).
- Atmospheric chemistry research.
- Increased study of climatology.

The basis for meteorological research remains weather forecasting, according to the report, and an atmospheric sciences program which could explain the weather could predict it.

Only the first 50,000 ft of the



CAM	ORBIT	FRAME	ROLL	TIME
1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50

Tires Camera Resolution Shown

Landscape and cloud pattern photograph with the Rollei Comp. of Aeronautics shows camera resolution in high-light contrast. On-line and color data is recorded below the picture. From left, each camera covers 100,000 sq mi. Photo is sub-tilted with open-upward frames for used reference.



JULY 22, 1963

MANNED SPACE FLIGHT ISSUE

The most important development of this decade, **MANNED SPACE FLIGHT**, will be the subject of the July 22, 1963 issue of **AVIATION WEEK & SPACE TECHNOLOGY**. **MANNED SPACE FLIGHT**, the major segment of the national space program, is planned at \$20 billion for a manned lunar landing. The total space budget requested for fiscal 1964 alone is a record \$7.3 billion.

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Themes of the issue will stress future programs from Project Apollo to manned permanent moon bases, manned orbiting space stations and interplanetary Mars and Venus flights. Editorial highlights will include:

- Major progress report on Project Apollo, its hardware and technical developments
- Status Report on Project Gemini two-man spacecraft including joint NASA-USAF operations.
- What we learned from Project Mercury and how it built a technical foundation for future manned space flight programs.
- Technical needs of military in manned space flight, including Dyna-Soar, Aerospace Plane, maneuverable reentry vehicles, inspection and surveillance satellites
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Saturn Forming Process Improved

Costly labor and long periods of forming Saturn 5 (Saturn) alloy tank plates has been eliminated by Boeing Co.'s Wichita, Kan. Div. by forming the plates at the same time the material is aged in an electric arc-melting furnace. Normally the 13 x 35-ft plates would first be formed with press brakes at forming mills and then heat-treated. The process involving a unitized way in the press. Combined operation eliminates the warping. Photo shows Boeing technicians mounting plates on a Saturn prior to aging-forming process.

required over as was slightly more than a hemisphere of the globe.

To correlate with the mathematical model, a large ring of steel was used to represent the actual structure. The model was then placed in the atmosphere and the ring was placed in the atmosphere.

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or more means, use the least expensive of all observational methods.

A typical observation program required in the worldwide atmospheric surveillance system, as outlined in the Academy report, would track water vapor exchange processes, surface gas exchange, atmospheric stratospheric, and recovering solar radiation in stratospheric.

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Compressing Real-Time Human Effectiveness

—this approach is to still look two lemmings of the column of and control data planes; the amount of information that can be reliably gathered and viewed ... and the amount that can be provided to the human decision maker in real time without exceeding the threshold of human reduction.

An illustration of this dual-dimensional systems approach may be seen in the Strategic Air Command Control System 485 A, for which ITT International Electric Corporation is Prime Contractor.

Built under the 485 L contract from Bessie Communications Controls is one of the world's first C2C systems capable of as many as 1,500 messages per hour by means of up to 32 transcribed dials. All messages transmitted within the System are automatically routed, received, and error checked by Data Transmission Control Centers located at each SAC Headquarters. Information flows into the Data Processing Center, where a high speed computer compares events reported

by BOC's with plans stored in its memory. The SAC will automatically alert the SAC staff to any significant deviation between actual and planned events.

At the critical area/485 L interface, accumulation of the vast quantities of information brought up into SAC command centers has been greatly enhanced by a recent ITT development—data presentation in audio. Operating at speeds that approach inaudible only a short time ago, the new display system enables computer outputs to be converted to a single audio tone—photographed—developed and projected onto 40 large central control screens in as many as 7 colors in a matter of seconds.

If you can see Phoenix, New Jersey today, you'll find a complete operational prototype of 485 L, occupying over 20,000 square feet in one of our facilities. This operational installation may also be used to simulate almost any command control or information system our engineers wish to study... military or commercial.

OPPORTUNITIES IN MANY COMMAND AND CONTROL AREAS NOW OPEN TO SYSTEMS ENGINEERS, ANALYSTS, AND OTHERS

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Write fully in strict confidence to Mr. E. A. Smith, Manager of Employment, Dept. 38 WY, ITT International Electric Corp., Room 127 and Garden State Parkway, Newark, New Jersey.

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INTERNATIONAL ELECTRIC CORPORATION

form to another by mechanisms which release latent heat could be improved by solar. Radiative processes in the atmosphere are also thought to be related to the transfer of energy in water and need to be considered. The authors suggested the U.S. space sciences program include studies in the Great Lakes and Caribbean.

Weather Modification

Large-scale modification of weather could come about through a better understanding of atmospheric responses to energy inputs, the researchers report. Observations of cloud patterns such as monsoons and tropical cyclones in the meteorological regime could serve as analogues energy inputs.

The effect of changing the radiative characteristics of the upper atmosphere or modifications in the troposphere and of introducing a source of energy in the lower atmosphere, on its subsequent circulation, are other important questions that need to be answered. The committee and Standardized equipment and observation techniques throughout the overall program also were urged.

The high atmosphere studies would involve measurement of the behavior of features of gases under gravitational, electrical and magnetic forces and bombardment by photons and particles covering a wide spectrum of energies and intensities. The meteorological research would be primarily concerned with the 20-30 mi. high portion of the

atmosphere and its effects on radio propagation. Major efforts in atmospheric chemistry studies would be global trace experiments to determine the controlling influence of carbon dioxide, and water in the atmospheric heat balance.

Complementing these studies would be observations of artificially introduced chemical, radioactive and biological tracers to reveal the large-scale behavior of air and the relative proportion of the atmosphere. Weekly soundings from 100 sparse sounding stations were proposed.

Climate Studies

Climate study research would include studying past, present and future climates with efforts toward exploring the possibilities and consequences of widespread climatic patterns throughout the world. Included would be studies on earth motions to longitudes radii activity. Biometeorology, a new discipline, would cover problems between biology and meteorology and would study the great changes being made by man on his own environment due to the significant population growth that has occurred during this century.

Strengthening the overall research program would be a meteorological service department to disseminate the results of the work being done and to define the relation between science and research facilities among academic and industrial institutions.



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Navy's first Patrol Cat Hydrofoil (PCH-10) "High Point" demonstrated its capability of its newly advanced hull on "Point Sound." Submarine chase it designed its speed in excess of 18 mph. Automatic controls, results to an aircraft carrier system, keep ship stable in 6 ft. sea. Ship is intended for use in coastal and inland waters. Prime contractor for the Navy hydrofoil is the Boeing Co.



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FINANCIAL BRIEFS

Northern Corp's sales for the nine months ended Apr. 26 totaled \$277.9 million, with a net income of \$6 million—\$1.45 per share. Comparable figures last year showed sales of \$245.5 million, with earnings of \$6.1 million—\$1.51 per share. Apr. 28 order backlog stood at \$325 million compared with \$150 million a year earlier.

Fireball Systems Corp. reported a net loss of \$1.2 million on sales of \$113.1 million for the first quarter of 1963. First quarter 1962 showed earnings of \$160,000 on sales of \$27.5 million. Losses were attributed to delays in completion of some programs and starting costs of new ones. Also, a decision was made to write off an uncompleted contract where cost overruns are anticipated.

American Machine & Foundry Co. had a net income of \$5.4 million on sales and rentals totaling \$69.4 million for the first quarter of 1963. Comparable figures for last year showed a net income of \$7.6 million on sales and rentals of \$125.9 million.

Westinghouse Electric Corp. earned \$12.6 million on sales of \$68.7 million for the first quarter of 1963. Shareholders last year showed earnings of \$11.8 million on sales of \$168.5 million. First quarter earnings were 34 cents per share this year and 32 cents last year.

Bolt-Race, Ltd. reported 1962 profits equal to \$4.9 million on sales of \$50.5 million. Figures for 1961 showed profits of \$7 million on sales of \$143.2 million.

Lockheed Aircraft Corp. reported a net income of \$10.8 million—\$1.50 per share—on sales of \$463.2 million for the first quarter of 1963. Comparable figures last year showed a net income of \$7.8 million—\$1 per share—on sales of \$392.1 million. Aircraft work accounted for \$205 million in sales, missile and space work for \$204.9 million, and retooling, electronics and propellers for \$13.2 million.

Thompson Radio Works, Inc. had sales of \$117.4 million, with a net income of \$1 million—equal to 30 cents per share—for the first quarter of 1963. First quarter 1962 showed sales of \$111.7 million and a net income of \$2.6 million, equal to 75 cents per share.

Genesee Aircraft Engineering Corp. reported \$1.9 million earned on sales



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The Missile Systems R&D Division at NASA/Columbia offers scientists and engineers at the advanced degree level the opportunity to do basic research and development work in the areas of:

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Plan and conduct analysis of missile systems requirements for naval applications. Establish operational conditions, target characteristics and missile performance requirements.

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Conduct applied research studies of aerodynamic heating, aerothermochemistry and heat transfer phenomena associated with advanced missile configurations.

FLIGHT MECHANICS

Conduct advanced analysis in flight dynamics and dynamic behavior of closed loop systems using analog computers and dynamic flight simulators. Emphasis on determination of requirements for advanced missile systems.

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of \$106.7 million for the first quarter of 1961. Comparably, 1962 figures showed \$2 million earned on sales of \$44.9 million. Earnings were 66 cents per share and 94 cents per share for the 1961 and 1962 periods, respectively. Order backlog stood at \$745 million on Mar. 31, compared with \$345 million on Mar. 31, 1962.

International Telephone and Telegraph Corp. had earnings of 58.4 and loss equal to 56 cents per share on sales and income of \$270.9 million for the first quarter of 1961. Comparably, figures for last year showed \$1.3 million earned—69 cents per share—on sales and income which totaled \$242 million.

Ampac Corp. reported \$1.7 million—45 cents per share—earned on sales of \$29.4 million for the first half of its fiscal year ended Mar. 31. Comparably, figures for last year showed \$1.6 million—\$1.21 per share—earned on \$17.9 million in sales.

United Aircraft Corp. reported a net income of \$1.7 million on sales and other income of \$279.9 million for the first quarter of 1961. First quarter 1962, birds showed a net income of \$4.6 million on sales of \$277.6 million. Comparably, sales were down \$14 million but were offset by increased billings from development and prototype contracts. Government sales showed little change. Order backlog stood at \$1 billion on Mar. 31, compared with \$1.016 billion a year before.

R.F. Goodrich Co. reports 1961 sales above the \$612 million peak reached in 1962 and profits higher than the \$26.1 million earned last year. President J. W. Kooner told stockholders that declining product prices, which has cost the company \$108 million per year, have stimulated cost-reduction programs are saving about \$25 million annually.

Thiokol Chemical Corp. reported earnings of \$1.5 million, equal to 40 cents per share, on sales of \$63.8 million for the first quarter of 1962. Same period last year showed earnings of slightly more than \$1.4 million, equal to 38 cents per share, on sales of \$63.5 million.

Alouy Servomechanisms, Inc. earned \$342,312 on sales of \$134.4 million for the nine-month period ended Mar. 31, 1962, showed earnings of \$295,982 on sales of \$103.2 million. Per share earnings for the 1961 and 1962 periods were 69 cents and 35 cents, respectively.

Immediate Boeing openings on



The Saturn V will be the first world's largest rocket and one of the first developed specifically for scientific space programs. Boeing has primary development, building and test responsibility for the Saturn V first stage booster. This uniquely challenging program

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- ☐ mechanical design ☐ industrial ☐ manufacturing
- ☐ facilities ☐ high vacuum ☐ aerodynamics
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Assignments will be in New Orleans or Huntsville, Alabama. Other Saturn openings — as well as assignments on such additional Boeing missile and space programs as the Minuteman ICBM and the Dyna-Soar boost-glide vehicle — are available at Seattle, Cape Canaveral and Vandenberg AFB. Boeing pays travel and moving allowances to newly-hired personnel.

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FORM BEGINS ON PREVIOUS PAGE

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REFERENCES: Give full names, occupations and addresses. Professional (previous supervisor preferred):

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LIST TYPE OF WORK PREFERRED UPON EMPLOYMENT:

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 - increasing the accuracy of pulse and CW radar systems through ultrasonic and near-real-time calibration using satellites.
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